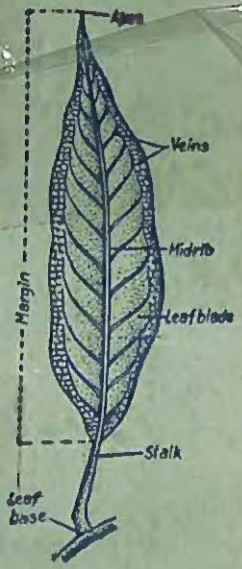
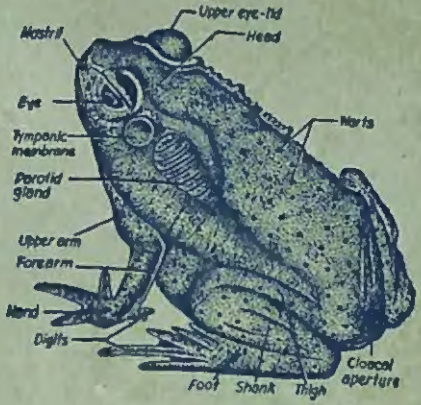
LIFE SCIENCE





DATTA · MUKHERJEE

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LIFE SCIENCE

Part III

[For Class VIII]

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PREFACE

This book has been written according to the latest syllabus in Life Science for class VIII of the West Bengal Board of Secondary Education. In presenting this book we have made our best effort to cover the contents of the whole syllabus in simple, lucid and understandable manner so that the students can make best use of it. Well illustrated diagrams presented in this book form an additional feature. We are sure that these will help the students in understanding the subject. We have restricted ourselves in presenting detailed description of some topics which we presume would cause unnecessary complications. In those sections we have tried to present them in understandable form.

We thank our publisher for inducing us to write this book and also for the valuable suggestions which were of much help to us. We also thank Sri Prabir Kumar Karmakar for bearing the trouble of drawing the diagrams of this book.

We shall feel our efforts amply rewarded if the book can help the students. Suggestions in any form regarding the improvement of the book will be gratefully appreciated.

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30th April, 1982

SYLLABUS OF LIFE SCIENCE

CLASS—VIII

1. Unit of life—Outline idea of a cell : Light microscopic study of cell membrane, cell wall, cytoplasm, nucleus, centrosome, Plastide, vacuoles, mitochondria and Golgi body.
2. Organisation of living body—Plant and animals.
   Tissue—definition and explanation.
   A. Plant Tissue—Outline idea of meristematic and permanent tissues (classification of meristematic tissue not required) Permanent tissue : Simple-parenchyma, collenchyma and sclerenchyma—structure, occurrence and function, Complex—Xylem and phloem—components, occurrence and function.
   B. Distribution of tissues in root, stem and leaf of typical dicot plant.
   C. Animal tissue : Outline classification of different types of (a) epithelial, connective, muscular and nervous tissues, difinition, occurrence and function.
   D. Organs and systems of animal—toad
   Alimentary, circulatory (detailed description of arterial and venous system not required), Respiratory, excretory, reproductive and nervous (mention only brain and spinal cord) systems.
   Note (i) Frequent references will have to be made to the similar organ system in human being.
   (ii) Functions of the different system should be mentioned in outline only.
3. Simple idea of Diffusion, Osmosis, Absorption, conduction and transpiration through experimentation.
4. A. Demonstration in the class through actual specimens, models and charts—(a) item specified in (1) and (2) in the syllabus. B. Free-hand section cutting method—root, stem, leaf of a typical young dicot plant.
5. Free-hand transverse section cutting of a young dicot stem by the students.
6. Experimentation and recording of Diffusion, Osmosis and Conduction.
7. Observation and recording of the external features of toad.

CONTENTS

LIFE SCIENCE

PART III

CHAPTER 1

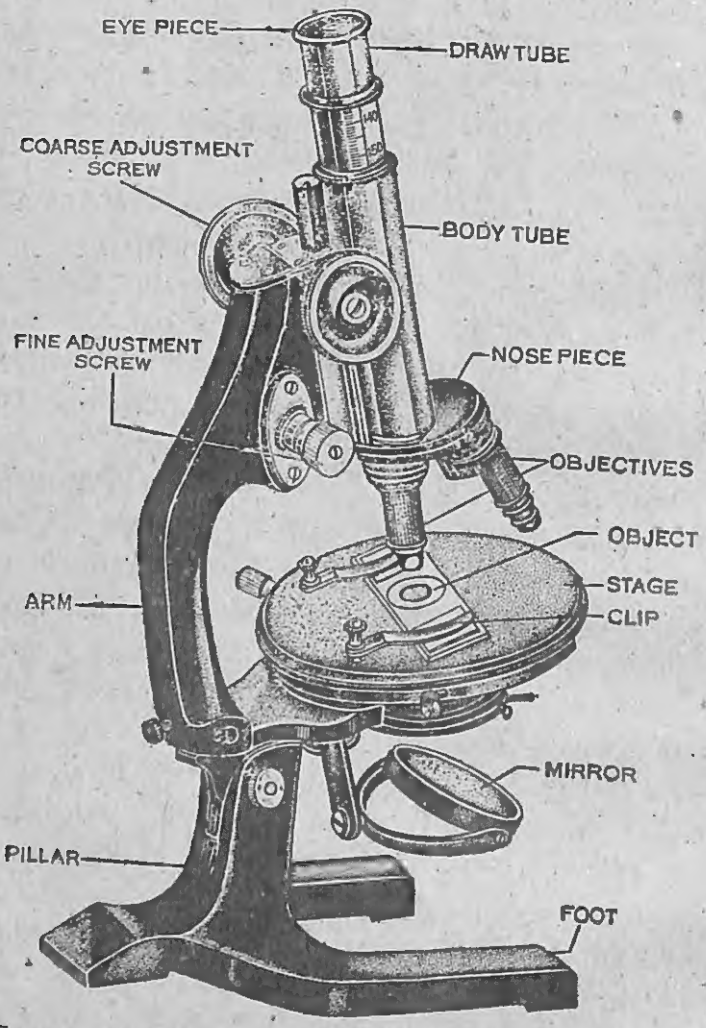
AN OUTLINE IDEA OF CELL

Have you seen a building during its construction? If the answer is 'yes' then you have definitely noticed how the bricks are placed one above the other for constructing the building. Thus we can say that bricks are the structural units of a building. Similarly, the body of plants and animals are made up of certain structural units called *cells*. Generally those organisms that are visible to us are multicellular *i.e.*, they are composed of many cells. Nevertheless there exists a vast number of organisms each of which consists of only a single cell. In such organisms, the single cell exhibits all the characteristics of life and maintains its independent existence. Although in multicellular organisms, the constituent cells are interdependent, yet the fundamental characteristics of life are evident in each of them. So, *a cell may be defined as the structural and functional unit of life.*

Each cell has a distinct boundary of its own and within it a complex semi-fluid substance called *protoplasm* is present. The life of a cell depends on the activity of the protoplasm. A cell fails to perform any function if the protoplasm dies or anyhow becomes inactive.

Cells vary considerably in their shapes and sizes. They may be spherical, ovoid, polygonal, retangular on even fairly elongated in shape. Cells are usually too small in size too be visible by the naked

eye. But some cells are quite visible to the naked eye. The egg cells of birds, cotton fibres, etc. are examples of such cells. The smaller cells can be



Compound microscope—an useful tool for the study of cell.

observed by an instrument called the *microscope*. It is made up of few lenses, a mirror and some other

mettalic parts. Microscopes actually give us a magnified view of the cell.

Microscopic study reveals that a living cell consists of several parts. Each part has a distinct structure and it performs a definite function or a group of functions. An account of the major characteristic parts of a generalized cell is given below.

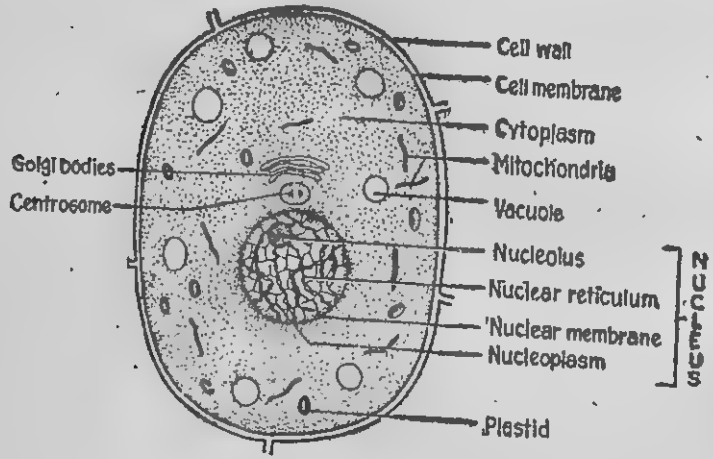
Cell membrane : All cells are bounded by a thin, flexible membrane called the *cell membrane*. It is also known as the *plasma membrane*. The cell membrane acts as the limiting membrane. It retains the cell contents and controls the transfer of food and waste materials into and out of the cell.

Cell wall : Plant cells, but not animal cells have a nonliving envelope lying just outside the cell membrane. The envelope is called the *cell wall*. The cell wall is made by the protoplasm but is not a part of it. The cell wall confers shape and to certain extent, rigidity to the cell. While the cell is growing, the cell wall is more or less plastic and extensible, but once the cell has attained full size, the wall becomes tough and resists stretching. Unless impregnated with special chemicals (as in the cells of bark), the cell wall is freely permeable to gaseous substances and water *i.e.*, allows them to pass through in either direction. Owing to the presence of cell wall, plant cells are often easier to demonstrate under a microscope than are the animal cells.

Cytoplasm : The semi-fluid part of the protoplasm is known as the *cytoplasm*. Usually it occu-

pies the region between the cell membrane and the nucleus. In the cytoplasm a number of chemical reactions, essential to life (e.g., part of respiration), is carried on. It contains various kinds of cell organelles (e.g., mitochondria, nucleus, etc.).

Vacuoles : There may be some cavities in the cytoplasm. These cavities are called the *vacuoles*. The vacuoles can occasionally be seen in animal cells but they are quite common in plant cells. In



A generalised cell.

a young plant cell, several vacuoles are found. But as it matures the vacuoles fuse together forming a large central vacuole which pushes the cytoplasm against the cell wall. The peripheral layer of cytoplasm thus formed is known as the *primordial utricle*. The vacuole is not empty but it is filled with a watery fluid. This fluid is known as the *cell sap*. The cell sap may contain mineral salts, sugars, etc. dissolved in water. The vacuoles are thus

regarded as storehouse of water, mineral salts, sugars, etc.

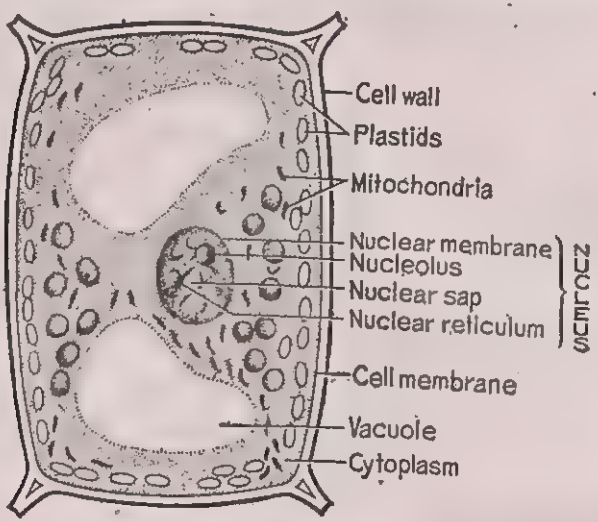
Nucleus : A specialized protoplasmic body called the *nucleus** remains embedded in the cytoplasm. It is much denser than the surrounding cytoplasm. Under a powerful microscope, the nucleus shows its different components. A delicate membrane called the *nuclear membrane* surrounds the nucleus. It separates the nucleus from the surrounding cytoplasm. The space within the nucleus is filled with a dense but clear mass of protoplasm known as the *nuclear sap* or *nucleoplasm*. It stores reserve materials that are used at the time of cell division. Suspended in the nuclear sap there is an irregularly branched network of delicate threads called the *nuclear reticulum* or *chromatin network*. It contains the hereditary material. One or more highly refractile, dense and spherical bodies called the *nucleoli* (sing. nucleolus) are found within the nucleus. They disappear during cell division. Without the nucleus the cell looses its capability of normal functioning, although it may continue to live for a certain length of time. It is thought to be a centre of 'chemical activity', playing a part in determining the function of the cell and controlling most of the physiological processes within the cell. The nucleus is regarded as the controlling centre of the cell.

Mitochondria : A number of minute proto-

* In some cells, more than one nucleus are present in each cell (e.g., skeletal muscle, certain algae and fungi). In some other cases an organised nucleus is totally absent (e.g., bacteria).

plasmic bodies called the *mitochondria* (sing. mitochondrion) occur in the cytoplasm in the form of granules or as tiny filaments. They are almost universally present in all the living cells. The mitochondria are associated with the respiration of the cell and considerable amount of energy is generated as a result of this process. The energy thus produced is utilized for various vital functions of the organism concerned. A mitochondrion is a sort of energy generator and it is regarded as the 'powerhouse of the cell'.

Plastids : Several small protoplasmic bodies known as the *plastids* are found in the cytoplasm



A typical plant cell.

of plant cells as discoidal or spherical structures. Plastids are characteristic of plant cells. They are of three types *viz.*, leucoplasts, chloroplasts and chromoplasts.

Leucoplasts—The leucoplasts are colourless plastids which are present in the underground parts of the plant body like roots. On exposure to light for a prolonged period leucoplasts transform into chloroplasts. The leucoplasts are concerned with storage of food materials.

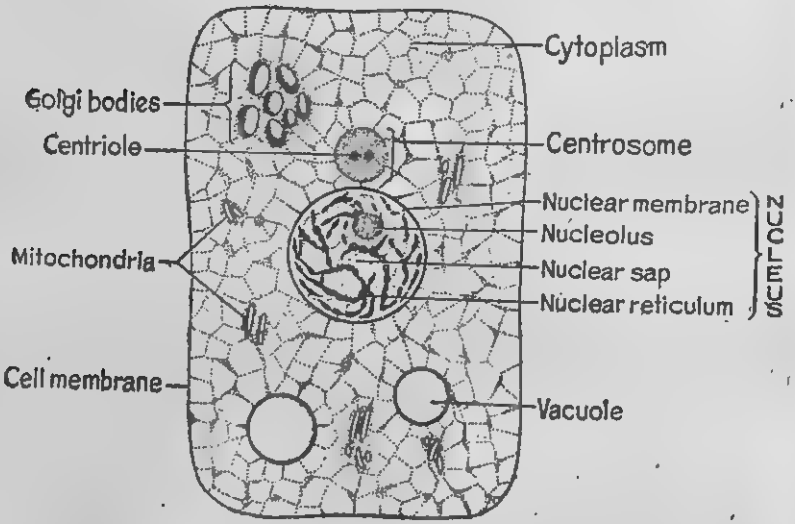
Chloroplasts—The chloroplasts are green plastids that are found abundantly in those plant parts which are exposed to light, as in green leaves. These plastids appear green owing to the presence of a green pigment known as *chlorophyll*. The chloroplasts transform into leucoplasts in the continued absence of light. The function of the chloroplasts is to prepare food in presence of sunlight. The food is prepared out of water and carbon dioxide obtained from the soil and the air respectively by a process called photosynthesis.

Chromoplasts—The chromoplasts are the variously coloured plastids and the colours which are commonly found are orange, yellow and red. They are most frequently found in the petals of flower, in the skin of fruit, etc. The brightly coloured petals having chromoplasts within their cells attract insects (for pollination i.e., transfer of pollens from the anther to the stigma).

Golgi bodies : The localized group of flattened sacs in the cytoplasm near the nucleus is known as *Golgi body*. Sometimes it may be composed of oval bodies arranged in parallel. It is named after the discoverer Camillo Golgi. The Golgi body was first detected in animal cells and it is less

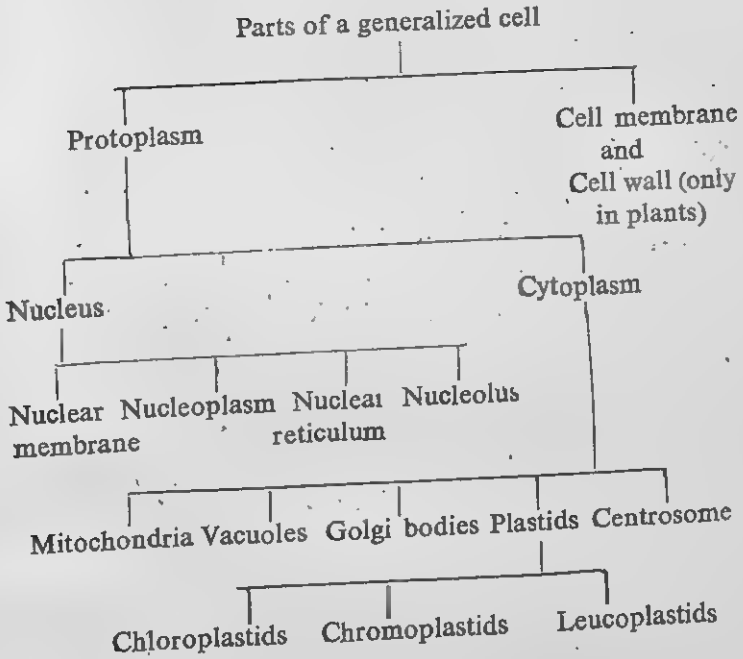
frequently found in plant cells. These structures are associated with the secretory activity of the cell.

Centrosome : Near the nucleus one or two rounded bodies called the *centrioles* remain surrounded



A typical animal cell.

by a recognizable region in the cytoplasm. This whole complex is known as the *centrosome*. It is present in all animal cells and in cells of some lower plants. It plays an important role during the cell division.



QUESTIONS

A. *General type questions :*

1. Define cell. Describe the different components of a generalized cell.

2. Draw a neat diagram of a typical plant cell and label its different parts.

3. What is nucleus? Describe its different parts.

4. What are the plastids? Describe the different types of plastids and their functions.

5. What is meant by cell wall? Where is it present? Describe its function.

B. *Objective type questions :*

6. Give short answers to the following questions :

(i) What is protoplasm ?

(ii) How a cell membrane differs from a cell wall ?

(iii) What is nucleoplasm ?
(iv) What is primordial utricle ?
(v) Which part of the cell acts as the 'power house' ?
(vi) Where are leucoplasts found ?
(vii) What is the function of centrosome ?

7. Write 'yes' or 'no' :

(i) Does an animal cell contain a cell wall ?
(ii) Does the whole content present within the cell membrane called protoplasm ?
(iii) Do the plant cells contain a large vacuole ?
(iv) Do you consider nucleus as a part of nucleolus ?
(v) Do the plastids occur in animal cells ?

8. Select the correct italicized word in the following sentences :

(i) All cells are bounded by a *cell membrane/cell wall.*
(ii) An young *animal/plant* cell contains many vacuoles.
(iii) Chromatin reticulum is found in the *cytoplasm/nucleoplasm.*
(iv) The *cytoplasm/nucleus* is regarded as the 'controlling centre' of the cell.
(v) *Mitochondrion/nucleus* is regarded as the 'power house' of the cell.
(vi) Leucoplasts are present in the *green leaves/roots* of plants.
(vii) *Golgi body/centrosome* is associated with the secretory activity of the cell.
(viii) *Chromoplast/centrosome* helps in the cell division.

9. Fill in the blanks :

(i) Egg cells of — are visible to the naked eye.
(ii) All cells are bounded by cell —.
(iii) Vacuoles contain a fluid called cell —.
(iv) — membrane surrounds the nucleus.
(v) The dense spherical body within the nucleus in called —.
(vi) Plastids are only present in — cells.
(vii) Centrosome contains one or two spherical bodies called—.

CHAPTER 2

ORGANISATION OF LIVING BODY

Plants and animals which we commonly see around us are mostly *multicellular*, *i.e.*, composed of many cells. But there are still others, each of which consists of a single cell. In such organisms (called unicellular) the single cell exhibits all the characteristics of life and can maintain its own existence quite independently. Whereas in multicellular organisms individual cell looses it independent existence. For example, a muscle cell exhibits all the fundamental characteristics of life but it cannot maintain its independent existence without the co-operation of the cells engaged in supplying food materials and oxygen to it or those which are involved in the removal of waste materials. In multicellular organisms, the constituent cells become specialized so that a particular function is carried out by one group of cells while another group functions another specific function and so on. Thus muscle cells show highest ability to shorten its length under appropriate condition, nerve cells carry efficiently information from one part of the body to the other, mesophyll cells efficiently manufacture food, etc. In multicellular organisms, cells which have similar origin and function tend to group together. Such a collection of cells is known as a *tissue*. In the following section we are presenting a brief account of plant and animal tissues.

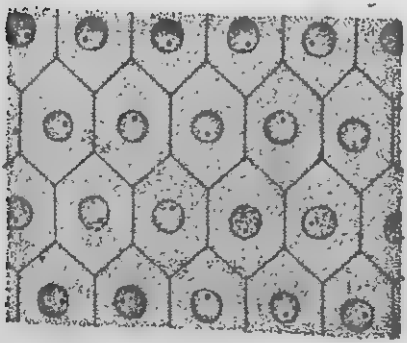
In this connection we should mention that these tissues always do not function independently. Several tissues maintaining their individual identity are aggregated to form *organs*, different but related organs form *system*, while the body of a higher organisms is made up of different systems (see also page 36). In higher animal different well organised systems may be readily demonstrated but such demonstration of systems even in higher plants is very difficult.

A. PLANT TISSUE

The body of a well organized plant at maturity is composed of various kinds of tissues. These are broadly divided into two main groups—(I) *meristematic* and (II) *permanent*.

I. MERISTEMATIC TISSUE

A meristematic tissue is composed of cells which can divide. The cells comprising the meristematic tissue are generally alike, compact and spherical, oval or polygonal in shape. Their cell walls are thin and the protoplasm in them are abundant where the vacuoles are either small or entirely absent.



Meristematic tissue—cross section.

Distribution : The meristematic tissue is found

to occur in the apical regions of the plant body (*e.g.*, root apex and shoot apex). It is also found in the vascular bundles of dicotyledonous stems (*e.g.*, cambium of sunflower stem).

Function—A plant grows by virtue of the meristematic tissue.

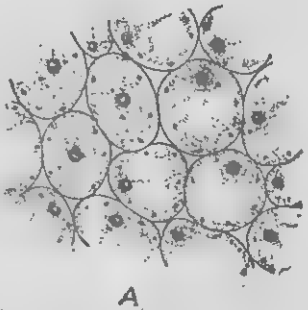
II. PERMANENT TISSUE

A permanent tissue consists of cells which usually do not divide. The cell constituting the permanent tissue may be living or dead and thin-walled or thick-walled. The permanent tissues are principally classified into (1) *simple* and (2) *complex*.

(i) SIMPLE TISSUE

A simple tissue consists of similar cells. There are three types of simple tissues viz., (a) *parenchyma*, (b) *collenchyma* and (c) *sclerenchyma*.

(a) **Parenchyma :** A parenchyma is composed of thin-walled living cells with or without chloroplasts. These cells are round, oval or polygonal in shape. While in group, the parenchymatous cells may leave spaces in between them (intercellular spaces).

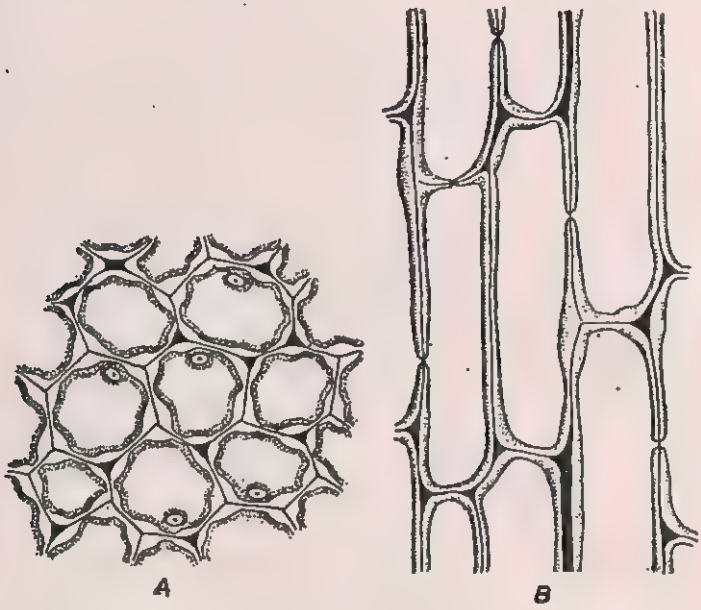


Parenchyma tissue—cross section.

Distribution—The parenchyma occurs in all soft parts of plants *viz.*, epidermis, cortex, pith, mesophyll of leaves, pulp of fruits, etc. This tissue is also present in the xylem and the phloem.

Function—Its main functions are preparation and storage of food.

(b) Collenchyma : A collenchyma is more or less similar to the parenchyma except that the cells



Collenchyma : A—cross section and B—longitudinal section.

comprising the former are thickened at the corners and they are somewhat elongated in shape. Usually these cells look polygonal in transverse section.

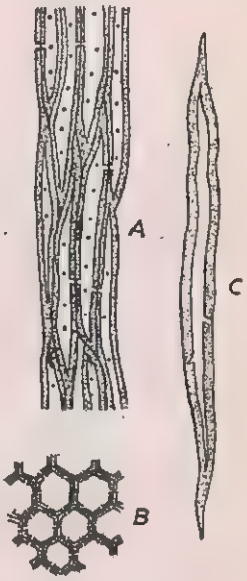
Distribution—The collenchyma is found to occur beneath the epidermis of dicotyledonous stems. (in the stems of sunflower, gourd, etc). It is also found in the petiole and the leaf blade and in the flower stalk.

Function : Usually the collenchyma cells give mechanical support to the plant organs. The chloroplast containing collenchyma cells can prepare food in presence of sunlight.

(c) Sclerenchyma : A sclerenchyma consists of polygonal cells which are usually narrow and elongated with pointed ends. Their walls are very much thickened and ultimately these cells become dead. The sclerenchyma cells are often called *fibres.*

Distribution—The sclerenchyma is found to occur in the vascular bundles of sunflower stem, in the pericycle of gourd stem, etc. It is also present in the vascular bundles as one of the components of the xylem and of the phloem.

Function—The sclerenchyma cells give strength and rigidity to the plant.

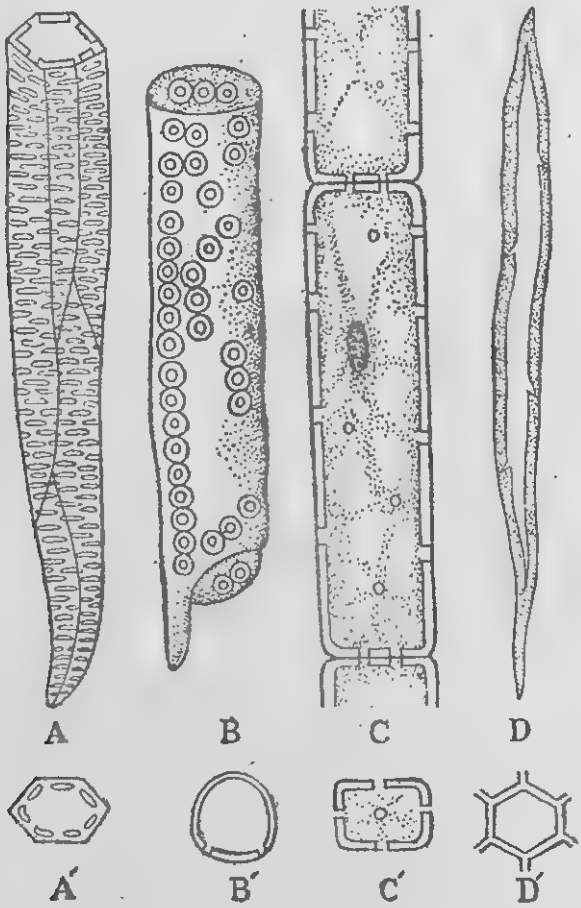


Sclerenchyma : A—longitudinal section, B—cross section and C—a single fibre.

(ii) COMPLEX TISSUE

A complex tissue is composed of more than one type of cells working together as a unit. There are two types of complex tissues *viz.*, (a) *xylem* and (b) *phloem.* The xylem and the phloem together form the conducting channels known as the *vascular bundles.* Hence, they are also called the *conducting tissues* or the *vascular tissues.*

(a) **Xylem :** Xylem is a complex tissue as it is composed of four different types of cells. These are (1) *tracheids*, (ii) *tracheae* (vessels), (iii) *xylem fibres* (wood fibres) and (iv) *xylem parenchyma*. The vessels are the most important constituent of the xylem. They are long tubes and are formed



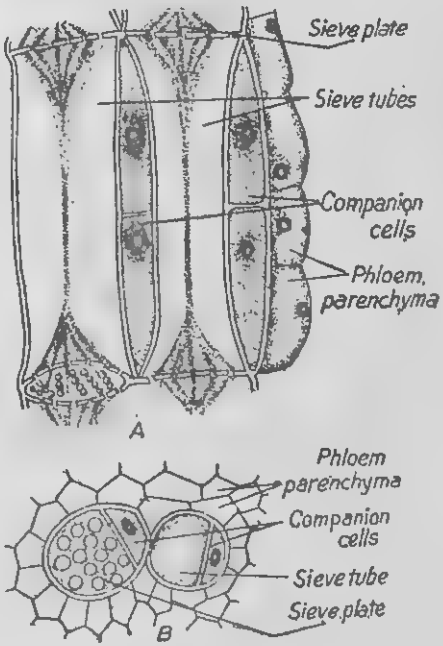
Components of xylem : A—tracheid B—trachea C—xylem Parenchyma D—Xylem fibre ; A to D—longitudinal sections and A′ to D′—cross sections.

from columns of dead cells whose cross walls have broken down. Among the different components of xylem, only the cells constituting the xylem parenchyma living.

Distribution—The xylem forms a part of the vascular bundle.

Function—Its main function is to conduct water and mineral salts in dissolved state from roots to leaves. The xylem also serves the mechanical function of strengthening the plant body.

(b) **Phloem :** Phloem is another complex tissue as it is also made up of four components, viz., (i) *sieve tubes*, (ii) *companion cells*, (iii) *phloem fibres* (bast fibres) and (iv) *phloem parenchyma*. The sieve tubes are the most important constituent of the phloem. They, unlike vessels, are columns of living cells whose cross walls are perforated; so dissolved substances can flow from one cell to the other.



Components of phloem : A—longitudinal section and B—cross section.

Distribution—The phloem also forms a part of the vascular bundle.

Function—It is meant for conduction of prepared food in dissolved state from leaves to other parts of the plant body.

B. DISTRIBUTION OF TISSUES IN DIFFERENT PARTS OF A YOUNG DICOT PLANT

Various kinds of tissues are distributed in an orderly manner in a plant organ (root, stem or leaf) and they are organized to form few tissue systems. A tissue system consists of either a single tissue or a combination of tissues which may or may not be structurally alike but perform a common function as a unit. In plants, various kinds of tissues form three different types of tissue systems. These are (a) *epidermal tissue system*, (b) *vascular tissue system* and (c) *ground tissue system*.

(a) **Epidermal tissue system**—The outermost skin of the plant organs constitutes the epidermal tissue system. It is composed of a single layer of cells and is mainly concerned with the protection of the plant organs. It is referred to as *epidermis* in case of stem and leaf whereas it is called *epiblema* in case of a root.

(b) **Vascular tissue system**—It is composed of a number of vascular bundles. Each vascular bundle consists of xylem and phloem which may or may not be separated by a layer of meristematic tissue called *cambium*. There are several vascular bundles in stem and leaf whereas the vascular bundles of the roots contain separate patches of xylem

and phloem tissues. The vascular tissue system is concerned with conduction.

(c) **Ground tissue system**—The tissues which are not included in the epidermal and vascular tissue systems constitute the ground tissue system. This tissue system is frequently divided into (i) *cortex*, (ii) *endodermis*, (iii) *pericycle* and (iv) *pith*. The ground tissue is mainly concerned with storage and occasionally with mechanical support. The ground tissue of leaf is called *mesophyll* and the latter is concerned with the preparation of food materials.

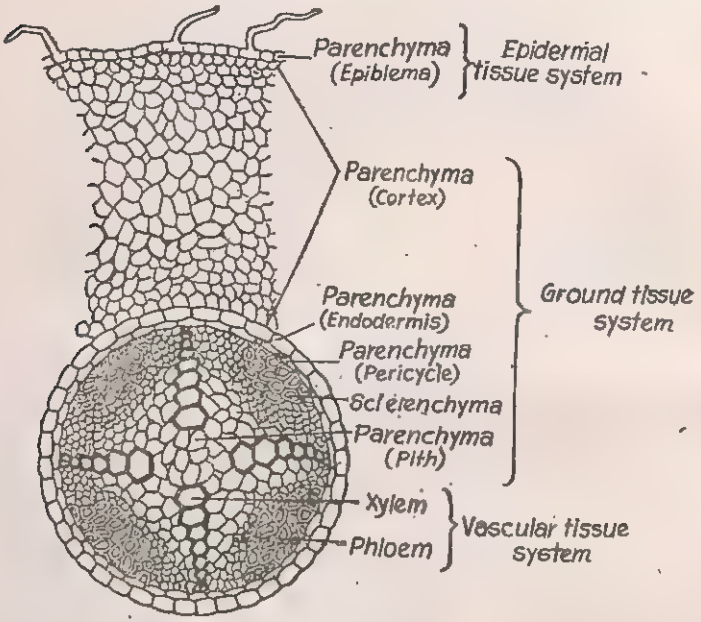
ARRANGEMENT OF TISSUES IN THE YOUNG DICOT ROOT

A thin cross section of a young gram root when viewed under the microscope shows the following arrangement of different tissues.

(a) *Epidermal tissue system*—A single layer of parenchymatous cells constitutes the outermost layer of the root (called the epiblema). There is no space (intercellular) between these cells. The cells are rectangular in shape and are thin-walled.

(b) *Ground tissue system*—It is formed by (i) few layers of roundish parenchymatous cells with conspicuous intercellular spaces in between them (constitute cortex), (ii) single layer of barrel-shaped closely fitted parenchymatous cells (constitutes endodermis), (iii) single layer of closely fitted smaller parenchymatous cells (constitutes pericycle) and (iv) a small region of closely fitted parenchymatous cells at the centre of the organ (called pith).

(c) *Vascular tissue system*—There are four xylem bundles and the same number of phloem bundles. Each xylem bundle alternates with the phloem bun-



Arrangement of different tissues seen in a cross section of a young gram root.

dle. There is a thin strip of closely fitted parenchyma in between the xylem and phloem. Another patch of sclerenchyma separates the covering membrane (pericycle) from each phloem bundle.

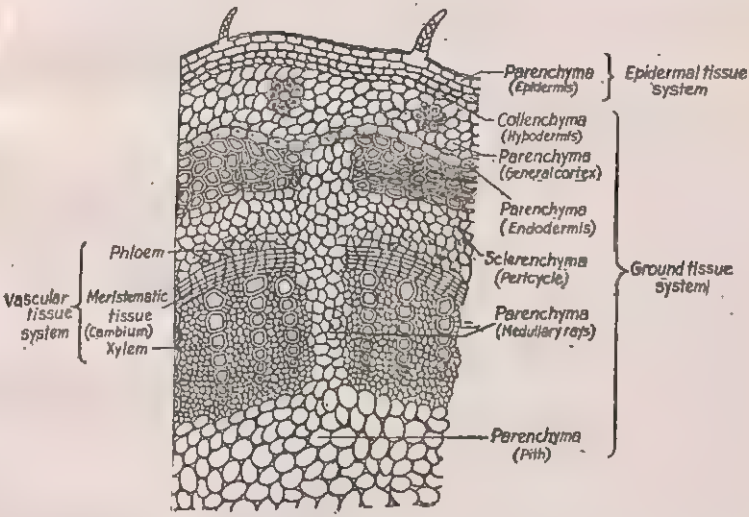
ARRANGEMENT OF TISSUES IN THE STEM OF A DICOT PLANT

A thin section of a young sunflower stem when viewed under the microscope shows the following arrangement of different tissues.

(a) *Epidermal tissue system*—The outermost

layer or the skin forms the epidermal tissue system or the epidermis of the stem. It is composed of a single layer of parenchymatous cells. These cells have the general shape of bricks and have no space in between them.

(b) *Ground tissue system*—It is composed of (i) a zone of several layers of collenchyma cells (hypodermis-outer cortex), (ii) a zone of few layers of roundish parenchymatous cells with conspicuous intercellular spaces in between them (constitute



Arrangement of different tissues seen in a cross section of a young sunflower stem.

general cortex), (iii) a single layer of closely fitted barrel-shaped parenchymatous cells (endodermis), (iv) a zone of fewer layers of parenchymatous or sclerenchymatous cells (constitute pericycle), those being present above the vascular bundles are sclerenchymatous in nature (form bundle cap), and (v) a zone of parenchymatous cells occupying the core of

the organ (it is the pith) and some parenchymatous cells which extend into the spaces in between the vascular bundles (form medullary rays).

(c) *Vascular tissue system*—Xylem and phloem tissues constitute the vascular bundles which lie in the form of a ring. In each vascular bundle, phloem is present on the outer side while xylem occupies the inner side. A strip of meristematic tissue consisting of thin-walled rectangular cells separates xylem and phloem tissues of each vascular bundle (called cambium).

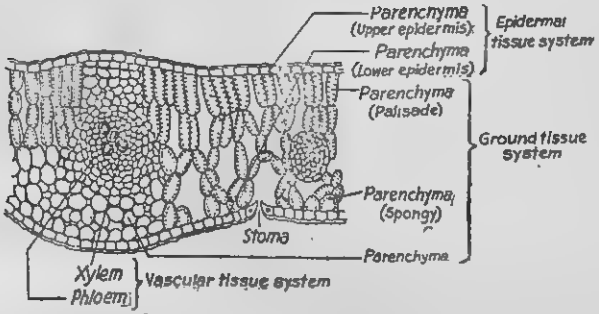
ARRANGEMENT OF TISSUES IN A DICOT LEAF

A cross section of a mango leaf when viewed under the microscope reveals the following arrangement of tissues :

(a) *Epidermal tissue system*—The epidermal tissue system of a dicot leaf consists of two separate layers (called upper epidermis and the lower epidermis.) Each of them consists of a single layer of closely fitted parenchymatous cells. The upper layer is continuous while the lower layer is discontinuous due to the presence of certain openings (called stomata).

(b) *Ground tissue system*—The ground tissue system of mango leaf includes the tissues present in between the upper layer and lower layer of the epidermal tissue system except the vascular bundles distributed within it. It is also called the *mesophyll.* The upper part of the mesophyll consists of two or three layers of closely fitted columnar cells. These cells contain many chloroplasts (the

upper part of mesophyll is known as palisade parenchyma). The lower part is composed of loosely



Arrangement of different tissues seen in a cross section of a mango leaf.

arranged roundish parenchymatous cells. These cells also contain chloroplasts (this zone is known as spongy parenchyma).

(c) *Vascular tissue system*—Vascular bundles constituting vascular tissue system remain distributed in the mesophyll. Some vascular bundles are larger in size while others are smaller in size. Each bundle is enclosed by a sheath of parenchyma or collenchyma which actually forms part of the ground tissue system. This larger vascular bundles are connected with the two surfaces by zones of parenchyma. In each bundle xylem faces the upper epidermal layer while the phloem faces the lower epidermal layer.

C. ANIMAL TISSUE

Most multicellular animals (above *hydra*) have definite tissue layers. In higher animals four different types of tissues can be readily recognised. These

are :—(a) *epithelial tissue*, (b) *connective tissue*, (c) *muscular tissue* and (d) *nervous tissue*.

EPITHELIAL TISSUE

This variety of tissue is composed of closely packed cell aggregates mostly lining the external and internal surfaces of the body. In such aggregates the cells are held together by a very thin layer of intercellular substance (it resembles the cementing substance present in between the bricks of a massonary wall). In epithelial tissue, most of the cells have one free surface. Sometimes during embryonic development, some of the cells of this kind of tissue may be modified to form the chief constituents of structures called glands. Thus *tissues which cover internal and external surfaces of the body or form the chief constituents of glands are known as epithelial tissue*.

Distribution—Epithelial tissue is present in the internal and external lining of the body, inner lining of the blood vessels and other hollow organs, all glands of the body, etc.

Functions—(a) The most important function of the epithelial tissue is to cover the internal and external surfaces of the body.

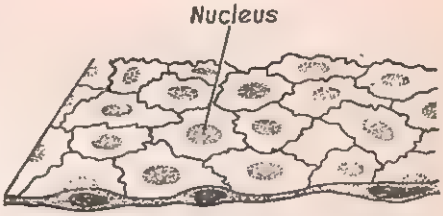
(b) In some places it also protects the underlying structures from mechanical injury.

(c) Moreover, this tissue may be involved in the absorption and secretion of important biological substances.

(d) In some places this tissue acts as a filtering membrane.

Classification—Epethelial tissues have been classified into several types depending on the number of cell layers and also on the basis of the shape of the constituent cells. You will learn them in higher classes. In this section we are presenting a short description of the simplest epithelial tissue—simple squamous epithelium.

Simple squamous epithelium : This type of epithelial tissue is composed of a single layer of thin (*i.e.*, flat) cells with irregular cell outline that fit together to form a thin membrane. The cells constituting this tissue resemble the general shape of the scales of fishes.



Simple squamous epithelium (shaded portion represents the side view)

Distribution—Epithelial tissue of this kind is present in the alveoli of the lungs, inner lining of the blood vessels, in the peritoneum and in some other places.

Functions—(a) This tissue acts as the covering membrane and thus protects the underlying structures. But due to considerable thinness of the constituent cells, this tissue cannot afford sufficient protection against mechanical injury.

(b) In some places this tissue may act as filtering membrane.

CONNECTIVE TISSUE

The tissue which serves the very important function of connecting the various tissues of the body is known as the connective tissue. This kind of tissue is composed of varying proportions of three different constituents :—(a) *connective tissue cells*, (b) *connective tissue fibres* and (c) *non-fibrillar intercellular substances.*

The cells which are commonly found in different connective tissues are fibroblasts, histiocytes, plasma cells, mast cells, fat cells and some wandering cells derived from the circulating blood (such as *neutrophil*, *eosinophil*, *lymphocyte* and *monocyte*).

Three types of fibres are commonly seen in different connective tissues. These are *collagenous fibre*, *elastic fibre* and *reticular fibre*. The collagenous fibres appear white in colour and thus it is also known as *white fibres*. It is the toughest fibre present in the connective tissues. The elastic fibres are branched and thus appear as reticulum in connective tissue. It has elastic property and thus makes the tissue somewhat elastic in nature. The reticular fibres are extremely thin and thus form a delicate network where it is present.

Non-fibrillar intercellular substances are of two types—(i) *ground substance* composed of complex organic substances and (ii) *tissue fluid* formed from the circulating blood.

Distribution—(a) It is present as wrapping around muscles, nerves and some parts of the central nervous system. (b) It is the chief constituent of the skeletal system (bone is in itself a variety

of connective tissue). (c) It is present around certain vital organs in the form of fat-pad. (d) Blood which flows through the vascular system is a kind of connective tissue (liquid connective tissue). (e) Structures called tendon (being present as a tough sheet attaches muscles with bones), ligament (attaches one bone with another), etc. are composed of connective tissue. (f) All glands of the body contain certain coverings called *capsule*. Connective tissue is the chief constituent of such capsules. Moreover, strands of connective tissue dips into the gland to act as the supporting tissue.

Functions—Connective tissue subserves the following important functions :—

(a) It acts as a link between the different tissues and organs of the body.

(b) Being the chief constituent of the skeleton it supports the body.

(c) Prevents the spreading of germs in the body and also helps in the protection of the body from foreign substances.

(d) Helps in the storage of fat in the body.

(e) Helps in the healing of wounds.

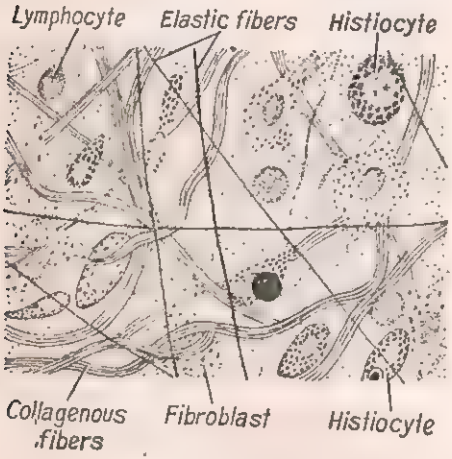
(f) Protects many vital organs from mechanical injury.

(g) Helps in the supply of food materials throughout the body and also in the removal of waste materials.

(h) In warm blooded animals (birds and mammals) it helps in maintaining a constant body temperature.

Classification—Depending on the proportions of cells, fibres and non-fibrillar intercellular substances connective tissues have been classified into several types. Among these *areolar tissue* (present below the skin), *dense connective tissue* (tendon, ligament, etc.), *adipose tissue* (present around certain vital organs such as heart, kidney, etc.) *cartilage* (present in pinna, nose, etc.), *bone*, *blood* (softest connective tissue) are important. In this section we are presenting a short account of the areolar tissue as a representative of the connective tissue.

Areolar tissue : This variety of connective tissue contains all types of connective tissue cells, fibres and a fluid like non-fibrillar intercellular substance. Moreover, the fibres are arranged loosely in this variety of tissue.



Areolar tissue.

Distribution—It is one of the most widely distributed tissues of the body. It is present just beneath the epithelial membrane of the body (such as beneath the skin), around the ducts of the glands, blood vessels, nerves and muscles.

Functions—(a) It helps in keeping different organs of the body in their normal positions.

(b) It prevents the spreading of germs from one part of the body to the other.

MUSCULAR TISSUE

Tissue which under appropriate state can bring about considerable shortening of its length is called muscular tissue. This tissue is composed of cells known as *muscle cells.* Each cell is much elongated in shape and for this reason it is more frequently referred to as a *muscle fibre.*

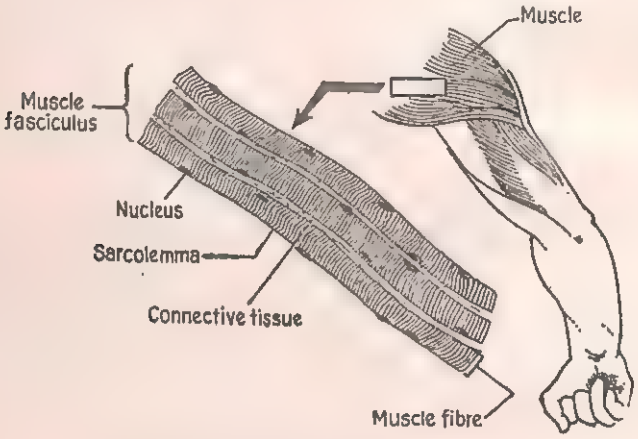
In higher animals three different types of muscles can be readily recognized—(a) *Skeletal muscle,* (b) *Smooth muscle* and (c) *Cardiac muscle.* Among these, skeletal muscle is present in highest proportion. The movement and locomotion of an animal depends on the activity of this type of muscle. Moreover, this variety of muscle is under voluntary control. *i.e.*, can be made to work by the desire of the individual.

Smooth muscle lines the walls of the visceral organs and also the walls of the blood vessels. This kind of muscle is free from voluntary control and is regulated by a separate division of the nervous system called the autonomic nervous system. This tissue is involved in the working of the internal organs (such as movement of alimentary canal, contraction of the urinary bladder, etc.) and maintenance of the tubular structure of the blood vessels.

Cardiac muscle is present in the wall of the heart. This tissue is involved in the pumping of blood through the blood vessels and like smooth muscle is free from voluntary control. In the following

section a short description of the skeletal muscle is presented.

Skeletal muscle : *Muscle which mostly remains attached with the skeleton and can be made to work by the desire of the individual concerned is called skeletal muscle.* Due to its striated appearance it is also called the *striated muscle.* In an animal body muscle fibres occur in groups. For example,



Skeletal muscle.

in human body some 12 or more muscle fibres form a small bundle called *fasiculus.* The term *muscle* is used to refer a collection of several fasiculi (singular fasiculus) covered by a common sheath of connective tissue. Within the fasiculus each muscle fibre has its own covering called *sarcolemma.* Outside the sarcolemma connective tissue is also present.

Each skeletal muscle fibre is cylindrical in shape, measures 0·1—1·0 mm in diameter and may extend upto 50 cm. in length. The cytoplasm of muscle

fibre is called *sarcoplasm* and like many other cells is rich in mitochondria and contains few elongated nuclei. The sarcoplasm is not homogeneous but is filled with numerous fibrils called *myofibrils.* Due to special arrangement of muscle proteins (actin and myosin) each myofibril shows alternate dark and light areas along its length. Due to the parallel arrangement of the myofibrils, the whole muscle fibre appears striated (such striations are not present in smooth muscle while cardiac muscle shows striations but these are not so distinct as the skeletal muscles).

Distribution—In general skeletal muscles remain attached with the bones. But in certain locations they may not be attached with the bones, such as the wall of the buccal cavity, tongue, upper part of the oesophagus, etc.

Functions—(a) The chief function of the skeletal muscle is to help in the movement and locomotion.

(b) Skeletal muscles present in the larynx helps in the production of voice.

(c) Skeletal muscles present in between the ribs (intercostal muscles) help in respiration.

(d) In many organisms skeletal muscles take part in the defensive mechanism.

(e) Activities of the nervous system are manifested through the muscles.

(f) In warm blooded animals activities of the skeletal muscles help in the maintenance of a constant body temperature.

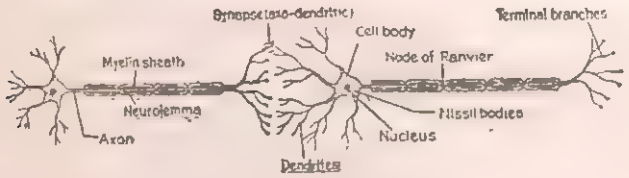
NERVOUS TISSUE

The tissue which forms the structural basis by which information from one part of the organism is transferred to the other part is known as the nervous tissue.

The nervous tissue is composed of two types of elements—(a) *neurones* and (b) *neuroglia*. Neurones are the structural and functional units of the nervous system while neuroglia (several types are present) perform the supporting function like the connective tissue in many other organs.

Neurone : With limited exceptions neurones can be divided into three parts—(a) *cell body* or *perikaryon*, (b) *dendrons* (also called *dendrites*) and (c) *axon*.

Perikaryon—Perikaryon is the part of the neurone which contains the nucleus. Usually only one nucleus is present in each neurone but neurones containing more than one nucleus are also present.



Neurones and synapse.

The membrane that covers the perikaryon also extends over its processes *i.e.*, dendrons and axon. The cytoplasm present is called *neuroplasm* and it is granular in nature. Many fibrils called *neurofibrils* extend from the dendrons to the terminal part of the axon. Neuroplasm contains numerous

small granules called *Nissl bodies*. The perikaryon also contains Golgi body and mitochondria.

Dendrites—Generally the short but profusely branched processes of the neurone are called dendrites. Sometimes neurone may contain only one dendrite looking more or less like the axon. Diameter of dendrite decreases and the number of branches increases as it moves away from the perikaryon. Dendrites contain neurofibrils and Nissl bodies. Dendrites are connected either with receptors (specialized structures capable of receiving information about the changes in the surroundings) or with the terminal branches of axon.

Axon—The single long but less profusely branched process of a neurone is called the axon. It arises from a point on the cell body called *axon hillock*. The membrane which covers the axon is known as the *axolemma* and the fluid enclosed by it as the *axoplasm*. This fluid is rich in neurofibrils and mitochondria. It does not contain Nissl bodies. In some neurones, the axolemma is surrounded a glistening white covering called *myelin sheath*. But it is not continuous throughout the length of the axon. At certain places it is totally absent, such a point is known as a *node of Ranvier*. Neurones which contain myelin sheath are called *medullated neurones* and which do not contain it are called *non-medullated neurones*. Outside the brain and spinal cord (see page 34) all neurones whether medullated or non-medullated contain another covering called *neurolemma* or *sheath of Schwann*. Neurolemma, in fact, is composed of several schwann cells arranged

in a single row. In case of medullated neurone, the space in between two successive nodes of Ranvier is covered by one schwann cell. The myelin sheath in those neurones is also formed from the schwann cell membrane. The axons of both types of neurones terminate by forming several terminal branches.

Distribution : Neurones are the structural and functional units of the nervous system. The nervous system has two parts—(a) *central nervous system* consisting of *brain* and *spinal cord* and (b) peripheral nervous system consisting of nerves and ganglia. The brain and spinal cord can be readily divided into two parts—*gray* and *white matter*. Gray matter is rich in cell bodies, non-medullated nerve fibres and neuroglia. The cell bodies of different neurones constituting the central nervous system are located in the gray matter. The white matter is rich in medullated nerve fibres and it also contains some neuroglia. Due to their shape, the dendrites and axons of neurones are called the *nerve fibres*. Collection of nerve fibres together with their connective tissue coverings is called a *nerve*. The cell bodies of the neurones which constitute the peripheral nervous system are either present in the brain or spinal cord or in certain specialized structures called *ganglia*. (singular-ganglion).

Function : (a) The chief function of the nervous tissue is to bring about co-ordination in the activities of many interdependent cells of the multicellular animals.

(b) Moreover, this tissue enables an organism to become aware of the changes taking place in the

surrounding and to respond appropriately to those changes.

Dendrites carry information towards the cell body while axons carry information away from the cell body.

Synapse : Within the nervous tissue neurones are connected with each other. The junction between two neurones is called a *synapse*. In such a region one of the terminal branches of the axon of one neurone comes in close contact with either a dendrite or the cell body of another neurone. The former type is called a *axo-dendritic* and the latter as the *axo-somatic synapse*. In a synapse there is no cytoplasmic connection between the two participating neurones. For this reason a chemical substance released from the axonic part participates in establishing communication between the two neurones.

Distribution : Synapses are always present either within the gray matter of the central nervous system or within the ganglia present outside the central nervous system.

Function : (a) Several neurones when linked through synapses can act as long communicating channels.

(b) Moreover, information carried by neurones are considerably modified at the synaptic regions.

D. ORGANS AND SYSTEMS OF ANIMAL

You have already noticed that in higher animals body cells have become specialized and their independent existence have become largely obliterated.

In those organisms, cells having similar origin and function have aggregated to form *tissues*. In most animals four different types of tissues are commonly found. In multicellular organisms different tissues, each making its own contribution, collect to perform a special function. Such a collection of different tissues in called an *organ*. For example, lung is an organ for respiration. It is composed of two different kinds of tissues—epithelial and connective. Similarly, stomach is an organ engaged in digestion. It is composed of all the four different types of tissues. Now if you study the working of different organs of the body, such as heart, lung, blood vessels, respiratory passages, stomach, intestine, kidney, brain, spinal cord, etc. you will find that there is close relationship among certain organs. For example, heart and blood vessels are functionally related. Similarly, there is close functional relationship between lungs and respiratory passages. Such a collection of different but related organs for carrying out a specific function or a group of functions is called a *system*. The body of a multicellular organism is composed of several such systems. In the following section we are presenting a brief account of some major systems of a common amphibia—the toad.

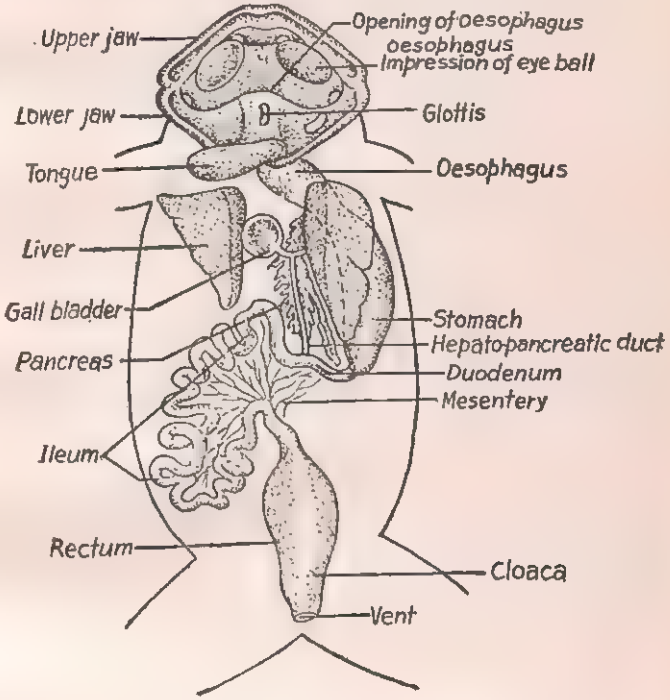
SYSTEMS OF TOAD

ALIMENTARY SYSTEM

The system concerned with the digestion, absorption of food and removal of undigested material from the body is known as *alimentary system*. It is

composed of (a) a tube-like structure called *alimentary canal* or *digestive canal* and (b) some glands called *digestive glands* that remain associated with the alimentary canal.

Alimentary canal : It is a long tube which begins anteriorly in the mouth and ends posteriorly at the cloacal aperture. It acts as the site for digestion and absorption of food materials. This tube is swollen in some parts and is narrowed or coiled in some other parts. For this reason it can be divided



Alimentary system of toad.

easily into the following parts—*mouth, buccal cavity, pharynx, oesophagus, stomach, small intestine, large intestine, cloaca* and *cloacal aperture.*

(a) Mouth—It is the wide opening located at the anterior end of the head and is guarded by the upper and lower jaws. Both the jaws are toothless.

(b) Buccal cavity—The specious cavity lying next to mouth is called buccal cavity. The roof of the buccal cavity contains one pair of *internal nostrils*, *impressions* of *two eyeballs* and a pair of *eustachian apertures*. The internal nostrils communicate with the *nasal canals* and each eustachian aperature is connected with the tympanum of that side of the body. The floor of the buccal cavity is occupied by a large fleshy *tongue*. The anterior end of the tongue is fixed while its posterior end is free. It is much sticky in nature and can be flicked out of the mouth to capture its prey. There is a longitudinal slit called *glottis* just behind the tongue. It communicates with the laryngo-tracheal chamber (see respiratory system).

(c) Pharynx—The posterior end of the buccal cavity narrows to form the pharynx. The latter joins the buccal cavity with the oesophagus.

(d) Oesophagus—The part of the alimentary canal next to pharynx is known as oesophagus or *gullet*. It connects the pharynx with the stomach.

(e) Stomach—It is a thick walled spacious sac. The broader anterior part of the stomach is known as *cardiac stomach* while the remaining posterior part is known as the *pyloric stomach*. The junction between the pyloric stomach and the next segment of the alimentary canal *i.e.*, small intestine is guarded by a sphincter called *pyloric sphincter*. It regulates the entry of semidigested food material into the

small intestine. Actual digestion of food materials in toad starts in the stomach. The wall of the stomach contains certain glands which secrets a digestive juice called *gastric juice*.

(f) **Small intestine**—It is the largest segment of the alimentary canal. It looks like an elongated tube of uniform diameter. It can be readily divided into two parts—(i) the small upper U-shaped portion known as *duodenum* which receives a common duct arising from the liver and pancreas, and (ii) the long folded posterior part called the *ileum*. Due to considerable length, the ileum shows much folding. These folds are held together and also attached to the body wall by means of thin membrane like structure called *mesentary*. Like the wall of the stomach, there are several glands on the wall of the small intestine. They too secrete a digestive juice called *intestinal juice*. Digestion of food materials becomes completed in this part of the alimentary canal. The inner lining of the ileum is thrown into several finger like foldings called *villi* (sing. villus). These are the structures engaged in the absorption of digested food materials.

(g) **Large intestine**—The terminal portion of the ileum leads to a wider segment called the large intestine. It is divisible into two parts—(a) the anterior flask-shaped part is called the *rectum* and (b) the narrower posterior part is called the *cloaca*. This part of the alimentary canal takes no part in digestion. Here the undigested food materials are converted to faecal matter.

(h) Cloaca—It is a common chamber where urine, faecal matter and germ cells (sperms or ova) are received. The cloaca opens to the exterior through an aperture called the *vent* or the *cloacal aperture*.

Digestive glands : Besides the glands on the wall of the stomach and small intestine two important digestive glands (glands secreting digestive juices) are connected with the alimentary canal by means of a common duct. These are pancreas and liver. Among these two glands liver is larger in size. The liver consists of two lobes—left and right lobes. The left lobe is larger in size than the right lobe. Both the lobes are connected by a bridge. A fluid called *bile* comes out from the liver. It passes through the hepatic ducts and is stored in the *gall bladder*. The gall bladder is a dark green spherical sac located in between the two lobes of the liver. The hepatic ducts from the liver and cystic duct from the gall bladder unite to form the *common bile duct*. The latter then passes through the pancreas which is a pale yellow coloured serrated mass of tissue lying by the side of the stomach. During its passage through the pancreas, the common bile duct receives numerous minute pancreatic ducts. For this reason the common bile duct when comes out of the pancreas is known as the *hepato-pancreatic duct*. It subsequently opens into the lumen of the duodenum.

Human digestive system—The human alimentary system also consists of *alimentary canal* and *digestive glands*. The basic plan of the alimentary canal and

the digestive glands are more or less similar to that of the toad but the human alimentary system is more developed and contains some additional structures. Some of the conspicuous features are (a) presence of teeth on both the jaws, (b) presence of three pairs of salivary glands attached to the buccal cavity, (c) anterior part of the tongue is free, (d) presence of an intermediate segment called jejunum in the small intestine and (e) separate opening of the rectum to the exterior.

Functions of the alimentary system : This system is concerned with the digestion (mechanical and chemical conversion of complex food materials into simpler forms), absorption of food materials and also in the elimination of the undigested materials outside the body. Besides this, it also plays some role in the excretion of certain substances such as heavy metals (example iron), bile pigments, etc.

RESPIRATORY SYSTEM

Living organisms require oxygen. This oxygen is utilized for the oxidation of food materials and during this process carbon dioxide and energy are released. These organisms utilize this energy for different body functions. Oxidation and liberation of energy take place inside the mitochondria of different body cells.

In multicellular organisms, entry of oxygen inside the body takes place in a much complicated way. In toad and in many other multicellular organisms the air (oxygen is present in it) is first drawn into certain organs called *respiratory organs.*

Within this respiratory organ exchange of gases takes place between air and the circulating blood brought to this organ. Such exchange of gases (here oxygen from air passes into the blood and carbon dioxide from the blood passes into the air present in the respiratory organ) is known as *external respiration*. Haemoglobin present in red blood cells plays a vital role by forming loose combination with oxygen. In the next step this blood is distributed throughout the body and thus it goes close to the different body cells (in toad there is no direct contact between blood and the body cells). Then another gaseous exchange takes place between the circulating blood and the body cells. This latter exchange is known as *internal respiration* and it also includes the actual utilization of oxygen.

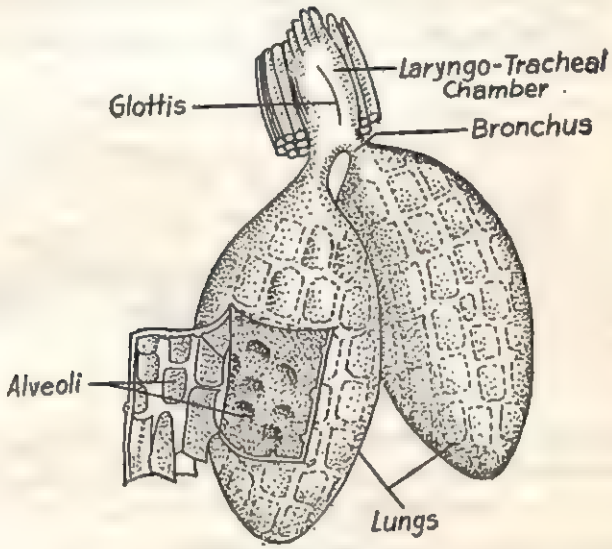
In toad external respiration occurs at three different organs. These are (a) *lungs*, (b) *moist skin* and (c) *the lining membrane of the buccal cavity*. External respiration taking place in these organs are known as *pulmonary respiration*, *cutaneous respiration* and *buccal respiration* respectively.

The organs which are involved in the external respiration collectively constitute the *respiratory system*.

(a) **Pulmonary respiration**—The organs involved in the pulmonary respiration are (a) *external nares*, (b) *nasal canals*, (c) *internal nares*, (d) *buccal cavity*, (e) *glottis*, (f) *laryngo-tracheal chamber*, (g) *bronchi* and (h) *lungs*.

The pair of *external nares* are located a little behind the mouth. These are the pores through

which the nasal canals open to the exterior. Two short *nasal canals* connect the external nares with the *internal nares* located on the roof of the buccal cavity. The *buccal cavity* opens into the *laryngo-tracheal chamber* by means of *glottis*. The laryngo-



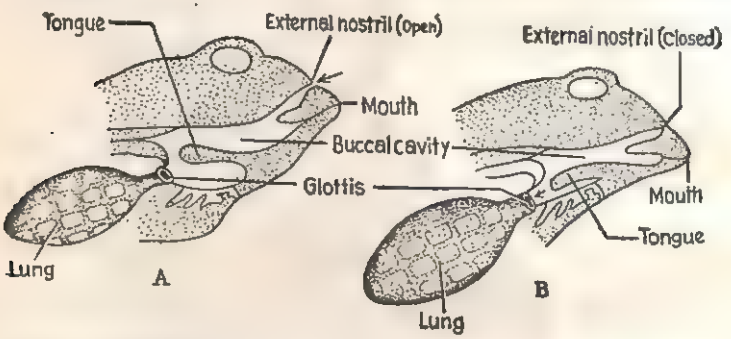
Respiratory organs of toad.

tracheal chamber subsequently communicates with the pair of *lungs* by means of two short tubes called *bronchi* (sing. bronchus). The two lungs lie on the two sides of the heart within the anterior part of the body cavity. Each lung is a pink coloured elastic sac and it can be inflated or deflated by air.

Within the lung bronchus divides and redivides to form minute channels which finally connect with minute sac-like structures called *alveoli* (sing. alveolus). Each alveolus has a network of capillaries which surround it and due to extreme thinness

of the alveolar wall, easy exchange of gases between the blood in the capillaries and the air in the alveolus takes place. Each lung contains a huge number of alveoli.

During pulmonary respiration air first enters into the buccal cavity mostly due to the lowering of the floor of the buccal cavity. This process is known as



Relative positions of different organs of the respiratory system of toad during aspiration (A) and inspiration (B). Arrows indicate the direction of air-flow.

aspiration. At this time, the glottis remains closed and so air cannot enter into the lungs. Immediately after aspiration nostrils get closed and trunk muscles contract. This exerts a pressure on the lungs and thus air from the lungs is forced into the buccal cavity when there is mixing of inhaled air with that coming from the lungs. Then nostrils get open and a part of this mixed air comes out of the body. This latter process is known as *expiration*. Immediately after expiration the external nostrils get tightly closed and the floor of the buccal cavity is raised. Due to such movement air from the buccal cavity is forced into the lungs. This process is

known as *inspiration*. During all these movements the mouth remains closed. So, if the mouth of a toad is kept forcibly open for sometime it dies.

Cutaneous respiration : The moist skin of toad acts as an additional respiratory organ. This is possible because the skin is richly supplied with blood vessels. Due to this structural peculiarity a direct exchange of gases occurs between the atmospheric air and the blood flowing through the blood vessels of the skin. This type of respiration goes on continuously and it is very helpful when the animal hibernates during the winter.

Buccal respiration—The lining of the buccal cavity also acts as an additional respiratory organ. The lining membrane (also called the mucous membrane) is richly supplied with blood vessels. Thus when air enters into the buccal cavity during aspiration easy exchange of gases (external respiration) occurs between air and the blood passing through the blood vessels of the lining membrane.

Human respiratory system : In human, only pulmonary respiration takes place. The basic plan of the pulmonary respiratory system is more or less similar to that of the toad, but it is much more developed. Major characteristic features of the human respiratory system are—(a) the presence of trachea connecting the pharynx with the bronchi and the absence of laryngo-tracheal chamber, (b) presence of diaphragm in the body cavity separating the lungs and heart from other organs of the body cavity and (c) presence of bony ribs and muscles between them increases the efficiency of

drawing and expulsion of air into and out of the lungs.

Functions : The major function of the respiratory system is to supply oxygen to different body cells so that the latter can generate energy necessary for different body functions. This system is also involved in the removal of carbon dioxide produced during utilization of food materials *i.e.*, during respiration (in real terms it means oxidation of food materials for the production of energy). In this connection it should be remembered that respiratory system requires the co-operation of the circulatory system in this regard.

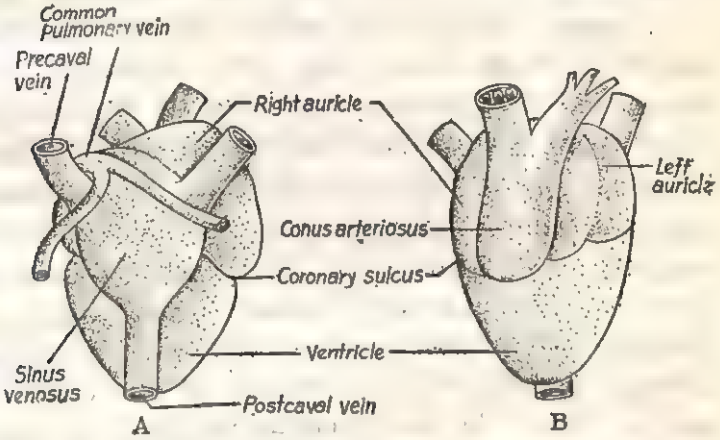
CIRCULATORY SYSTEM

The system concerned with the transport of food materials, gases and waste materials from one part of the body to the other is called the *circulatory system.* It consists of a muscular pumping organ called the *heart,* some tube-like structures called *blood and lymph vessels* and liquid conveying medium called *blood* flowing through the blood vessels and *lymph* flowing through the lymph vessels. In toad the circulatory system belongs to the *closed type of circulation i.e.,* in this type of circulation the blood flows through the vessels and never comes in direct contact with the body cells.

The circulatory system of toad can be broadly divided into two divisions—(a) *the blood vascular system* and (b) *the lymphatic system.*

Blood vascular system : It has three different components—blood, heart and blood vessels.

(*a*) *Blood*—It represents the softest tissue of the body and is pumped by the heart through the blood vessels. It consists of a yellowish fluid called *plasma* and three different types of cells called collectively the *blood corpuscles*. Plasma is a complex fluid rich in many organic and inorganic substances and the different blood corpuscles remain suspended in it. The blood corpuscles are of three kinds—(i) *red blood corpuscles* or *erythrocytes*, (ii) *white blood corpuscles* or *leucocytes* and (iii) *platelets* or *thrombocytes*. The erythrocytes are nucleated biconvex



Heart of toad : A—Dorsal (back side) view and B—ventral (front side view)

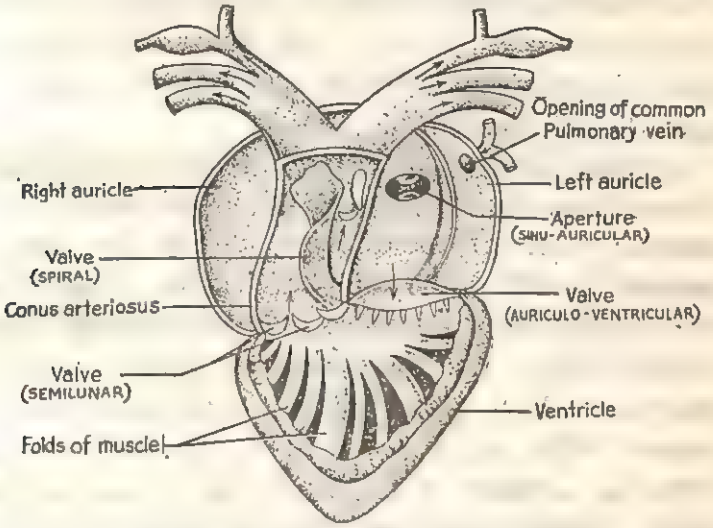
cells and appear reddish in colour due to the presence of a pigment called haemoglobin in them. Haemoglobin has the capability of forming loose combination with oxygen. The leucocytes also contain nuclei but they are devoid of any pigment. This variety of corpuscle is larger in size than the erythrocytes. Different types of leucocytes are

present in blood and they help in the protection of animal against foreign bodies. The thrombocytes are the smallest of all the corpuscles present in blood. These are spindle-shaped nucleated cells and play an important role in the clotting of blood.

(*b*) *Heart*—It is a hollow, pear shaped muscular organ lying in the anterior part of the body cavity in between the two lungs. It is completely enclosed by a transparent bag like covering called the *pericardium*. The broad base of the heart projects towards the head while the tapering apex points towards the liver. A thin-walled, triangular sac-like structure called *sinus venosus* is present on the back side of the heart. The three corners of this triangular structure are connected to three major veins called *caval viens*—two draining blood from the upper part of the body (anterior precaval viens) and one draining blood from the lower side (posterior precaval vein) of the body. The heart when viewed from the front side shows a deep furrow called the *coronary sulcus* and a stout tube-like structure arising roughly from the region of the coronary sulcus. This tube-like structure in called the *conus arteriosus*. After a short course towards the left it divides into two parts, each of which subsequently gives rise to several major arteries.

A longitudinal section of the heart shows four (altogether there are five cavities including the sinus venosus) cavities—two auricles, one vertricle and one conus arteriosus). The upper two cavities are called *auricles*—the *right auricle* and the *left auricle*. They are completely separated from each

other by a strong vertical partition called *inter-auricular septum*. Among the auricles the right auricle is larger than the left auricle. The right auricle communicates with the sinus venosus through an aperture. The latter is guarded by a pair of valves. It receives *deoxygenated* or the *impure blood* (rich in carbon dioxide) from the sinus venosus.



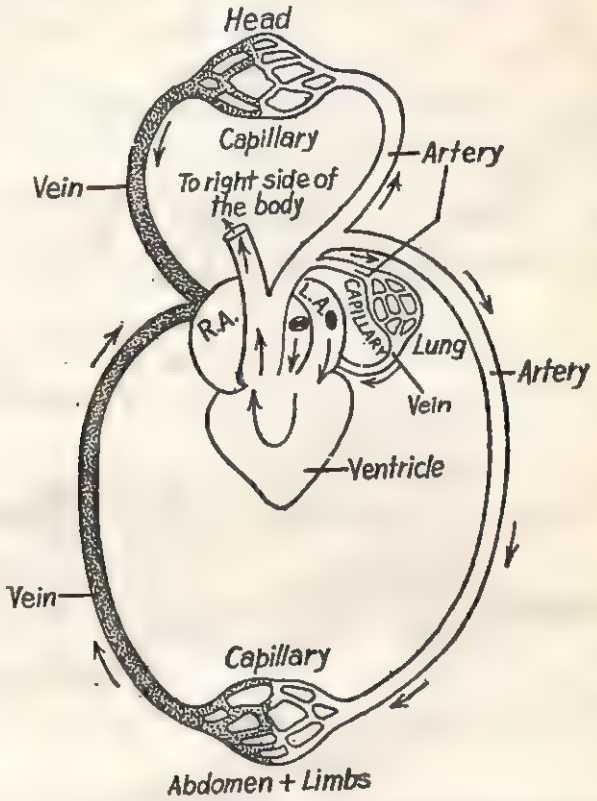
View of the internal structure of the heart following a longitudinal section (arrows indicate the direction of blood-flow)

The left auricle recives *oxygenated* or *pure blood* (rich in oxygen) from the common pulmonary artery through another aperture. The ventricle is a thick-walled conical chamber. It is present just below the auricles and communicates with the latter by a common opening. The coronary sulcus indicates the junction between the auricles and the ventricle. The aperture between the auricles and the ventricle is guarded by certain valve. The arrangement of the

valve is such that blood is only allowed to pass from the auricles to the ventricle but not in the reverse direction. The ventricular cavity contains many muscular folds which prevent complete admixture of blood coming from the auricles. A stout tube called *conus arteriosus* is attached to the base of the front side (ventral side) of the ventricle. Another set or valve guards the opening between the ventricle and the conus arteriosus. The cavity of the conus arteriosus is incompletely divided into two compartments by another flap-like valve.

(*c*) *Blood vessels*: Each part of the conus arteriosus arising from the ventricle gives rise to three major arteries. One of them carry mostly the deoxygenated blood to the lungs and skin. Other two carry mostly the oxygenated blood to different parts of the body. All these arteries divide to form *arterioles* which again subdivide to form minute vessels called *capillaries*. These capillary vessels form the capillary bed around the tissues of the body. Exchange of gases and other materials occur between the blood in the capillary vessels and a fluid bathing the tissues. This latter fluid is known as *tissue fluid*. At the same time exchange of gases and other materials also takes place between the tissue fluid and the tissues. The capillary vessels subsequently unite to form venules which then join to form veins. These latter vessels finally open into the caval veins. Due to gaseous exchange in the capillary bed blood flowing through the veins is rich in carbon dioxide and such blood is known as *deoxygenated* or *impure*

blood. In this connection it should be mentioned that the arteries carry blood away from the heart and

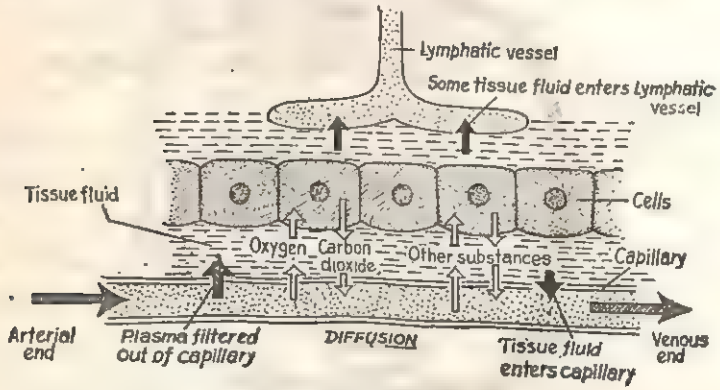


General view of the circulation of blood in toad (arrows indicate the direction of blood-flow; R.A.—right auricle and L.A.—left auricle)

with two exceptions (pulmonary artery and cutaneous artery) all arteries carry oxygenated blood. Veins carry blood towards the heart and with two exceptions (pulmonary vein and musculocutaneous vein) carry deoxygenated blood. Thus the blood vascular system of toad consists of three types of

blood vessels—arteries (including arterioles), capillaries and veins (including venules).

The lymphatic system : The lymphatic system of toad consists of lymph vessels, lymph sinuses, lymph hearts, lymph glands, and the fluid called lymph flowing through them. You have noted that exchange of gases and other materials occur only in the capillary bed. During this process a fluid also passes into the tissue fluid bathing the tissues. A considerable part of this fluid re-enters into the capil-



Relationship among a single capillary, a lymph vessel and body cells.

laries at the venous end and thus return to the heart. In addition to this, a small quantity of this fluid enters into another set of vessels that start as blind tubes in the tissue spaces. These vessels are called *lymph vessels* and the fluid passing through them as the *lymph*. It resembles plasma (fluid part of blood) in many respects but contains few leucocytes. The lymph vessels open into few lymph sinuses (which are large spaces filled with lymph) occurring at

several spaces in the body (*i.e.*, beneath the skin, around the kidney, etc.) Some of the lymph vessels are contractile and are knwon as *lymph hearts.* There are two pairs of lymph hearts in toad. They pump lymph into the veins. In addition to these structures two *lymph glands* (spleen is one such gland) are attached to the lymph vessels. Lymph flowing through the lymphatic system ultimately enters into the vein. It supplies oxygen and other materials to those tissues where blood cannot act as the transporting medium. Moreover, it takes part in the defensive mechanism of the body.

Human circulatory system—Well organised circulatory system is present in the human body. The basic plan of the human circulatory system is more or less the same as that found in the toad. But it is much more developed and certain conspicuous differences are present. Some of these are—(a) human heart has four chambers, sinus venosus and conus arteriosus are absent, (b) there is no mixing of oxygenated and deoxygenated blood in the human heart, (c) erythrocytes are non-nucleated, (d) lymphatic system does not contain lymph heart and lymph sinuses but contains many lymph nodes.

Functions : The chief function of this system is to transport food materials, gases and other useful substances from one part of the body to the other. This system also aids in the transport of waste materials (some of them are toxic) to the organs for excretion and also in the protection of the body.

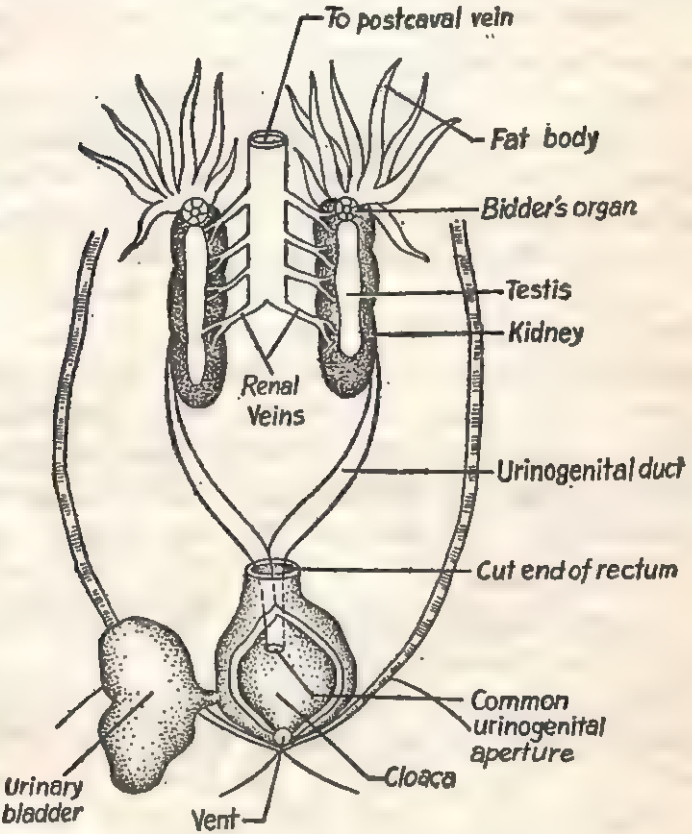
EXCRETORY SYSTEM

During actual utilization (metabolism) of food materials certain waste materials are formed in the body. Some of these waste materials are not only useless but if allowed to accumulate cause harmful effects. The removal of these waste materials outside the body is known as excretion and the organs involved in this process is known as *excretory organs.* Kidneys, Lungs, liver and skin are such excretory organs. All these organs collectively constitute the *excretory system* of toad. Among the different excretory organs, the kidneys function as the chief excretory organ. The pair of kidneys, a pair of ureters, one urinary bladder, cloaca and vent constitute the urinary system responsible for the elimination of all the nitrogenous waste materials outside the body. Thus the *urinary system* constitutes a part of the excretory system.

Kidney—The kidneys are the elongated flattened bodies situated on the back side of the body cavity, one on each side of the vertebral column. They are reddish brown in colour. Kidneys of toad are also known as wolffian body or mesonephros. Each kidney is composed of innumerable small *uriniferous tubules* (also called *nephrons*). One end of each tubule has a cup-shaped structure called *Bowman's capsule*. The latter almost encloses a tuft of capillaries called *glomerulus*. A small *afferent arteriole* derived from the renal artery actually forms the capillary tuft. These capillaries then unite to form the *efferent arteriole* which subsequently joins with the renal vein. The Bowman's capsule and glome-

rulus form *Malpighian body* or *renal corpuscle.* The other end of the uriniferous tubule opens into collecting tubule which latter opens into the ureter connecting the kidney.

Ureter—The ureters or the wolffian ducts are thin-walled whitish tubes which connect kidneys



Urinogenital system of a male toad.

with the cloaca. One end of each ureter is connected with one kidney while the other ends of both the ureters unite to form a common tube which opens

into the dorsal (back side) wall of the cloaca through the *urinary aperture.*

In the male toads sperms are also transported by the same route and for this reason the ureters and the urinary aperture are called *urinogenital ducts* and *urinogenital aperture* respectively.

Urinary bladder—It is a bilobed thin-walled sac that remains attached to the ventral (front side) wall of the cloaca. Its opening to the cloaca is guarded by a sphincter of muscle. Urine is continuously formed in the kidneys and is stored for variable periods in the urinary bladder. The cloaca communicates with the exterior through the *vent.*

On the anterior side of both the kidneys there are certain finger like structures called *fat bodies* but these are not included in the urinary system. These act as reserve food materials. Another elongated yellowish white structure called *testis* is present on the surface of each kidney of a male toad. It does not play any role in the excretory mechanism.

Human excretory system : In the human too, the excretory system consists of kidneys, lungs, liver and skin. The basic plan of the human excretory system is more or less same as that found in the toad, but that present in the human is more developed. Some of the most important features of the human excretory system are—(a) The nephrons in the human kidneys are more developed, (b) the ureters arising from the pair of kidneys open separately into the urinary bladder and (c) the urinary bladder communicates with the exterior through a

duct called *urethra* and structures like cloaca and cloacal aperture are absent.

Functions : The chief function of the excretory system is to eliminate the waste materials formed during utilization (metabolism) of the food materials outside the body. Among the different excretory organs, kidneys are engaged in the elimination of nitrogenous waste materials, some salts and water. Moreover, in the male toad the ureters also help in the transportation of sperms (male germ cells) outside the body.

REPRODUCTIVE SYSTEM

The system which is concerned with the generation of new individuals with similar characteristics through the formation of germ cells is known as reproductive system. Toads reproduce by the process of sexual reproduction which involves two types of individuals, male and female, readily recognizable by some external characteristics. During breeding season a cushion like structure called *thumb pad* appears at the bases of innermost and middle fingers of each forelimb of the male toad. Moreover, the male toad is provided with a vocal sac and its impression can be detected from outside.

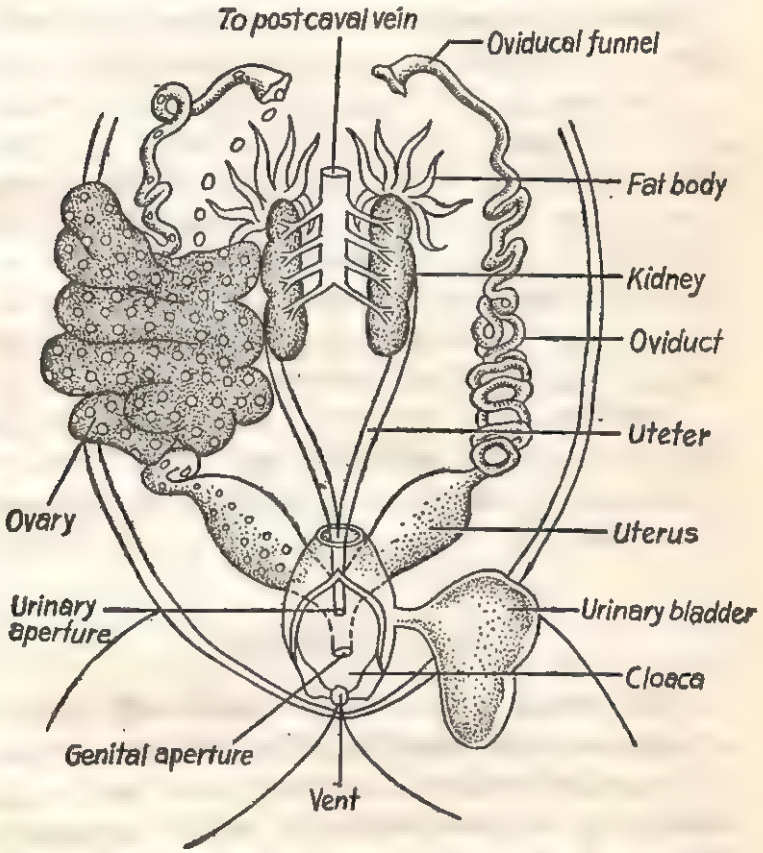
The reproductive system consists of the *gonads* (testes in males and ovaries in females) which produce the germ cells (sperms in males and ova in females) and the ducts which convey the germ cells outside the body. The reproductive organs of the male constitute the male reproductive system while those

of the female constitute the female reproductive system.

The male reproductive system—A pair of yellowish white elongated bodies called *testes* (singluar—testis) constitutes the gonad of the male. Each testis remains attached to the front (ventral) side of the corresponding kidney by a thin fold of membrane. Each testis contains a collection of tubules called *seminiferous tubules* which produce the sperms. These seminiferous tubules are connected with the collecting tubules of the kidney by means of several fine ducts called *vasa efferentia*. The sperms thus pass into the ureter which in the males serves as the conduit for both sperms and urine. For this reason, the ureter in the male is designated as *urinogenital duct*. Sperms thus pass through the urinogenital duct to the cloaca through the common urinogenital aperture and from the cloaca pass outside the body through the cloacal aperture. Just at the anterior end of each testis there is a small rounded body called *Bidder's organ*. Under normal condition it serves no function.

The female reproductive system—A pair of ovaries constitute the gonad of the females. Each ovary has an irregular and much folded sac-like structure. It remains attached to the front side (ventral) of the kidney by a thin fold of membrane. During breeding season, the ovaries, become considerably increased in size. There are two *oviducts*, one for each ovary, for the transportation of ova to the cloaca. There is no direct connection between the oviduct and the corresponding ovary. After matu-

ration eggs also called *ova* (singular—ovum) are released into the body cavity by the rupture of the ovarian wall. These ova are collected into the funnel-shaped end of the oviduct called *oviducal funnel*. The eggs then pass through the highly coiled middle part of the oviduct and finally appear



Urinogenital system of a female toad (left ovary removed)

in the expanded thin-walled posterior end of the oviduct called *ovisac* or the *uterus*. The two uteri

arising from the oviducts unite to form a common tube which subsequently opens on the dorsal (back-side) wall of the cloaca through the *genital aperture*. The eggs while passing through the oviduct receive a coating and accumulate in the ovisacs and are subsequently discharged to the exterior through the cloacal aperture.

Human reproductive system : Although the basic plan of the human reproductive system is more or less the same as that found in toad, yet it is much more developed. Some of the most impotant characteristics of the human reproductive system are—(a) the testes remain outside the body cavity, (b) Bidder's organ, cloaca and cloacal aperture are absent, (c) uterus opens separately to the exterior and (d) ovum under appropriate condition becomes fully developed inside the uterus.

Function : This system is concerned with the generation of new individual with similar characteristics and is, therefore, related with the perpetuation of the race.

NERVOUS SYSTEM

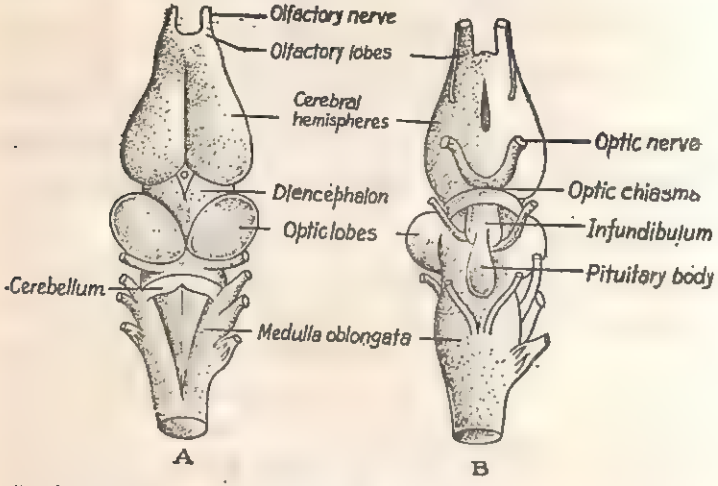
The system which is concerned with the co-ordination of the activities of the different parts of the body and enables an animal to respond to the changes in the environment is called the nervous system. It is divided into three major parts—(A) the *central nervous system*, (B) the *peripheral nervous system* and (C) the *autonomic nervous system*.

A. The central nervous system : The central nervous system consists of a hollow tube of nervous tissue whose anterior part enlarges to form the *brain* and the posterior part narrows to form the *spinal cord*. The hollow cavity of the brain is divided into several compartments called *ventricles* and that present within the spinal cord is known as the *spinal canal* or the *neurocoel*. The solid part of the central nervous system is composed of numerous nerve cells (or neurones) together with their processes (called nerve fibres) and neuroglia. Outer portions of the brain and inner portions of the spinal cord appear grey in colour due to the abundance of the cell bodies (perikaryons) of many neurones. Remaining portions of the central nervous system appear white as these portions are rich in nerve fibres. The whole central nervous system remains encased within bony cavities—it is the *cranial cavity* in case of brain and the *neural canal* in case of the spinal cord. Besides this bony covering, there are two connective tissue coverings called *meninges* surrounding the whole central nervous system. These are called *dura mater* and the *pia mater*.

Brain : It is the part of the central nervous system that remains within the cranium of the skull. It is readily divisible into three primary regions—(a) *fore-brain* or *prosencephalon*, (b) *mid-brain* or *mesencephalon* and (c) *hind-brain* or *rhombencephalon*.

(a) **Fore-brain** or **prosencephalon :** It is the anteriormost part of the brain. It is further divided into an anterior *telencephalon* and a posterior *dience-*

phalon. At the anterior end of the telencephalon there is a pair of small swellings called the *olfactory*



Brain of toad : A—Dorsal (back side) view and B—ventral (front side) view.

lobes. The olfactory lobes remain connected with the nose (truly with the nasal epithelium) by means of a pair of *olfactory nerves.* The rest of the telencephalon consists of two elongated bulging mass called the *cerebral hemispheres.* Each cerebral hemisphere again can be divided into two parts—*corpus striatum* and *pallium.*

The posterior part of the fore-brain is known as the *diencephalon* or the *thalamencephalon.* When viewed from the dorsal (back) side it appears as a depressed region immediately behind the cerebral hemispheres. Structures called *epiphysis* and *pineal body* are visible in this area. On the ventral (front) side a 'X'-shaped region formed by the crossing of the two optic nerves is visible. This X-shaped

structure is known as *optic chiasma*. A little behind the chiasma there is a projection called the *hypophysis* or *infundibulum*. A rounded structure called *pituitary body* is attached with it. Each side of the diencephalon expands to form the *optic thalamus* of that side.

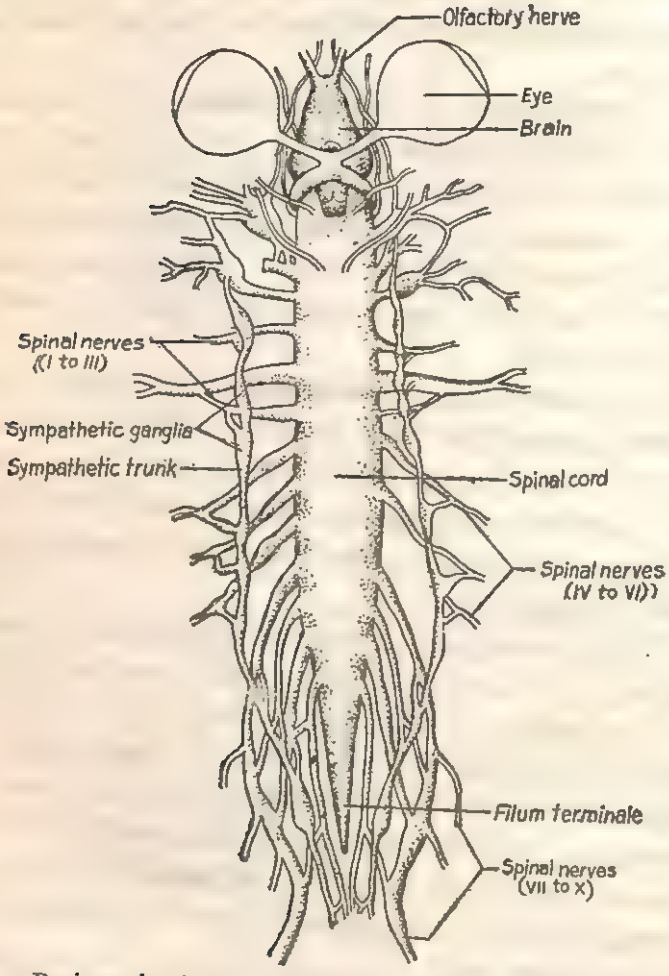
(b) **Mid-brain** or **mesencephalon**—It is located behind the thalamencephalon. On the dorsal side there are two hollow oval bodies called the *optic lobes*. On the ventral side there are two longitudinal bands formed by nerve fibres. These are called *crura cerebri* and they connect the fore-brain with the hind-brain.

(c) **Hind-brain** or **rhombencephalon**—The posteriormost part of the brain is known as the rhombencephalon. It is divisible into two parts—*metencephalon* and *myelencephalon*. The metencephalon is represented by a thin transverse band like structure called the *crebellum*.

The myelencephalon represents the posteriormost part of the rhombencephalon and it connects the rhombencephalon with the spinal cord situated below. The floor and the sides of the myelencephalon become much thickened to form the *medulla oblongata*. The posterior part of the medulla oblongata narrows at the foramen magnum (the largest opening at the base of cranium) becomes continuous with the spinal cord.

Cavities of the brain: We have already mentioned that the brain is not a solid mass of nervous tissue but it contains an hollow cavity that shows several compartments called *ventricles*. There are two

lateral ventricles within the cerebral hemispheres, one ventricle called *third ventricle* within the diencephalon and another called *fourth ventricle* within the medulla



Brain and spinal cord of toad (seen from ventral side)

oblongata. The fourth ventricle communicates with the cavity in the spinal cord called the *neurocoel*. The two lateral ventricles communicates with the third

ventricle through the *foramen of Monro* and the latter communicates with the fourth ventricle through the *aqueduct of Sylvius* (also called the *iter*). All these cavities remian filled with a fluid called *cerebro-spinal fiuid*.

Spinal cord—The spinal cord represents the hollow tube of neural tissue that extends posteriorly from the medulla oblongata. It starts at the foramen magnum, remains encased within the neural canal of the vertebral column and ends within the last vertebra (called urostyle). Like the brain, the spinal cord also remains invested by two meninges within the vertibral column. The cavity of the spinal cord called the *central canal* or *neurocoel* is continuous with the fourth ventricle and also remains filled with cerebrospinal fluid.

Peripheral nervous system : The peripheral nervous system of toad consists of 10 pairs of *cranial nerves* (each cranial nerve arises from the corresponding half of the brain) arising from different parts of the brain and 10 pairs of *spinal nerves* arising from the spinal cord (one nerve arises from one half of each segment of the spinal cord). Collection of several processes of neurones and their coverings is called a *nerve*. These nerves actually connect different parts of the body with the central nervous system and form the anatomical basis by which information from one part of the body can be transferred to the other. Some of these nerves carry information from per phery towards the central nervous system—these are called *sensory nerves*, others carry information from the central nervous

system to the periphery—these are called the *motor nerves*. There are still others which contain both the sensory and motor fibres—these are called the *mixed nerves*.

Autonomic nervous system : Certain portions of the central nervous system and few nerve fibres in both the cranial and spinal nerves control the activities of some vital organs (called visceral organs ; *e.g.*, heart, stomach, urinary bladder, etc.) of the body. This branch of the nervous system is called the autonomic nervous system. As for example, the two *sympathetic trunks*, lying on both sides of the spinal cord and few fibres in the vagus nerve (Xth cranial nerve) can be mentioned. You will learn this system in your higher classes.

Human nervous system: The basic plan of the human nervous system is more or less the same as that found in toad but that present in human is much more developed. Some of the important characteristics of the human nervous system are—(a) presence of a highly developed cerebral hemisphere, (b) presence of ill developed olfactory lobe, (c) presence of well developed cerebellum and (d) presence of 12 pairs of cranial and 31 pairs of spinal nerves.

Function : The overall function of the nervous system is to make co-ordination in the activities of the different parts of the body. Moreover, this system enables the organism to respond appropriately to the various changes in the environment so as to maintain its own existence. It is also related with memory, intelligence, consciousness and voluntary activities.

QUESTIONS

A. PLANT TISSUES AND DISTRIBUTION OF DIFFERENT TISSUES IN PLANT ORGANS

I. General type questions :

1. What is meristematic tissue? Where is it found? Describe its importance.

2. What is meant by permanent tissue? Describe briefly the different types of simple tissue found in the plant body.

3. What are the components of vascular tissue of the plants? Describe the importance of vascular tissue.

4. Write what you know about the arrangement of different tissues seen in the cross section of a young dicot root.

5. What is vascular bundle? Describe the components of a vascular bundle. Where are they found?

II. Objective type questions :

6. Wirte short answers to the following questions :

(i) What is tissue ?

(ii) How will you differentiate between parenchyma and sclerenchyma?

(iii) What the important function does the meristematic tissue play in the plant body?

(iv) What is the chief function of sclerenchyma ?

(v) What is xylem vessel?

(vi) What type of tissue is present in the outermost layer of a young dicot root?

(vii) What are the components of the ground tissue system?

7. Write 'yes or 'no'—

(i) Does a tissue always consist of similar cells?

(ii) Is the meristematic tissue located in the apical region of the plant body?

(iii) Does the parenchyma provide strength and rigidity to a plant organ?

(iv) Does the tracheids belong to xylem?

(v) Does the xylem tissue conduct foods prepared in the leaves to different parts of the plant body?

(vi) Do the mesophyll cells occur in the roots of plant?

(vii) Do the parenchyma cells lying below the epiblema constitute the pith of the root?

8. Select the correct italicised word in the following sentences :

(i) A plant grows by virtue of its *permanent/meristematic* tissue.

(ii) The main function of parenchyma is to *prepare food/provide mechanical support.*

(iii) *Sclerenchyma/collenchyma* cells are often called fibres.

(iv) Vascular bundles are composed of *xylem and phloem/xylem, phloem and other permanent tissue.*

(v) Tracheids and tracheae are found in *xylem/phloem.*

(vi) Phloem helps in *upward/downward* conduction.

(vii) The outermost layer of cells present in stem is called *epiblema/epidermis.*

9. Fill in the blanks :

(i) Meristematic tissue is composed of cells which—divide.

(ii) A plant grows by virtue of its—tissue.

(iii) Mesophyll of leaves are formed by—.

(vi) The walls of —are very much thickened.

(v) —are tube-like dead cells present in xylem.

(vi) —tubes are found in phloem.

(vii) Openings called—are present in leaf.

B. ANIMAL TISSUES

I. General type questions :

1. What is epithelial tissue? Where is it found? Give a short account of the nature, distribution and function of one type of epithelial tissue.

2. Name the different components of connective tissue and give some examples of common connective tissues.

3. What is skeletal muscle ? Why is it called so ? Give a short account of a muscle fibre.

4. What is neurone ? Give a short account of the processes of a neurone ?

5. What is synapse ? Describe its occurrence and function.

II. Objective type questions :

6. Write short answers to the following questions :
   (i) What is simple squamous epithelial tissue ?
   (ii) What is collagenous fibre ?
   (iii) What are the components of areolar tissue ?
   (iv) Where are the smooth muscles present ?
   (v) What is the most important characteristic of a muscle cell ?
   (vi) What is perikaryon ?
   (vii) What is neuroglia ?
   (viii) How will you differentiate between a medullated nerve fibre and a non-medullated nerve fibre ?
   (ix) What is meant by axo-dendritic synapse ?
   (x) What is meant by ganglion ?

7. Write 'yes' or 'no' :
   (i) Does the epithetial tissue form the chief constituent of the glands of the body ?
   (ii) Does the simple squamous epithelium provide sufficient protection against mechanial injury ?
   (iii) Does a tendon hold two bones together ?
   (iv) Does the smooth muscle represent the most widely distributed muscle in the body ?
   (v) Can you name the cytoplasm of a muscle cell as sarcoplasm ?
   (vi) Do the dendrites of a neurone contain nuclei ?
   (vii) Does the axon represent the longest process of a neurone ?

8. Find out the correct italicised word in the following sentences :
   (i) The simple squamous epithelium consists of *a single layer/many layers* of cells.
   (ii) Collagenous fibres are present in *epithelial/areolor* tissue.
   (iii) Movement and locomotion of an animal depend on *smooth/skeletal* muscle.
   (iv) A single skeletal muscle cell contains only *one nucleus/many nuclei.*
   (v) Nervous tissue is composed of only *neurones/neurones and neuroglia.*

(vi) Nodes of Ranvier are present only in *medullated/all* nerve fibres.

(vii) Gray matter of the brain is rich in *medullated/non-medullated* nerve fibres.

(viii) *Axons/dendrites* contain Nissl bodies.

(ix) A synapse formed between the axon of a neurone with the perikaryon of another neurone is called *axo-dendritic/axo-somatic* synapse.

(x) The diameter of the dendrite *increases/decreases* as it moves away from the cell body.

9. Fill in the blanks :

(i) Simple squamous epithelium is present in the —— of lungs.

(ii) Bone is a type of —— tissue.

(iii) The softest tissue of the body is —— .

(iv) A —— holds two bones together.

(v) Smooth muscle is present in the wall of —— vessels.

(vi) The membrane of a muscle cell is known as —— .

(vii) The part of a neurone where the nucleus is located is called —— .

(viii) The cytoplasm present in the perikaryon is called —— .

(ix) —— transmits information from periphery to the cell body.

(x) —— transmit information from the cell body to the periphery.

C. ORGANS AND SYSTEMS OF TOAD.

I. General type questions :

1. What is alimentary system ? Describe the different parts of the alimentary canal of toad.

2. What is meant by a digestive gland ? Describe the arrangement of different digestive glands of toad.

3. Describe the arrangement of different organs associated with the pulmonary respiration of toad.

4. What are the components of the blood vascular system of toad ? Draw a neat sketch of the longitudinal section of the heart of toad and label its different parts.

5. What is excretion ? Describe the arrangement of the organs of the urinary system of toad.

6. Describe the male reproductive system of toad. Why the ureters of male toad are called urinogenital ducts ?

7. What is central nervous system ? Describe the different parts of the brain of toad.

8. What is meant by the peripheral nervous system ? Describe in brief the peripheral nervous system of toad.

II. Objective type questions :

9. Write short answers to the following questions—

(i) What is an organ ?
(ii) What are villi ?
(iii) What is meant by external respiration ?
(iv) Write what you know about buccal respiration of toad.
(v) What is blood ? Describe its main components.
(vi) What is lymph vessel ? What is present inside it ?
(vii) What are the functions played by the lungs in external respiration ?
(viii) How will you differentiate between a male toad and a female toad ?
(ix) What is oviduct ?
(x) What is telencephalon ?

10. Write 'yes' or 'no'—

(i) Does the liver belong to the alimentary canal ?
(ii) Do the jaws of toad posses teeth ?
(iii) Does the skin of toad takes part in respiration ?
(iv) Do the bronchi form part of the respiratory system ?
(v) Do the leucocytes possess pigment in them ?
(vi) Do you find any pigment in the erythrocytes of toad. ?
(vii) Does the heart of a toad contain four chambers ?
(viii) Does the excretory system of toad include the skin ?
(ix) Do you consider Bidder's organ as an component of the urinary system of toad ?
(x) Does the spinal cord form part of the central nervous system ?

11. Select the correct italicised word in the following sentences :

(i) The *anterior/posterior* end of toad's tongue remains free.

(ii) The part of alimentary canal *anterior/posterior* to phyrynx is called oesophagus.
(iii) Duodenum is a part of the *small/large* intestine.
(iv) Entry of air into the buccal cavity of toad is called *aspiration/inspiration.*
(v) Veins carry blood *away from/towards* the heart.
(vi) There are *two/four* pairs of lymph heart in toad.
(vii) Pulmonary artery carries *oxygenated/deoxygenated* blood.
(viii) *Kidneys/lungs* form the chief excretory organ of the toad.
(ix) Ureters of toad are directly connected with the *urinary bladder/cloaca.*
(x) Testis contains many *uriniferous/seminiferous* tubules.
(xi) Bidder's organs are present in *male/female* toad.
(xii) Uterus forms part of the *oviduct/ureter.*
(xiii) The spinal cord forms part of the *central/peripheral* nervous system.
(xiv) Pituitary body remains attached to the *prosencephalon/mesencephalon.*
(xv) Cerebellum forms part of the *mesencephalon/rhombencephalon.*

12. Fill in the blanks :

(i) Alimentary system consists of —— canal and digestive glands.
(ii) The anterior part of the stomach is called —— stomach.
(iii) Rectum forms anterior part of the —— intestine.
(iv) —— glands are not present in toad.
(v) Skin also takes part in the —— of toad.
(vi) Many —— are found in the lungs of toad.
(vii) The transparent bag-like structure that completely encloses the heart is called —— .
(viii) There are —— chambers in the heart of toad.
(ix) Left auricle receives —— blood.
(x) The stout tube which is attached to the base of the front side of the ventricle is called —— .
(xi) —— blood is rich in carbon dioxide.

CHAPTER 3

SIMPLE IDEA OF SOME PHYSIOLOGICAL PHENOMENA THROUGH EXPERIMENTATION

You have already come to know that plants and animals require energy for performing several activities, such as growth, movement and locomotion, etc. Energy is derived by oxidation of food materials. For this purpose all organisms consume food or prepare it from simple ingredients. Living organisms require oxygen and they receive it from the air when the latter enters inside the body during respiration. The entry of simpler ingredients and oxygen inside the body and their utilization depend on several physiological processes. In this section we are presenting some basic idea about some of the physiological phenomena and some simple experiments to prove that these phenomenon definitely occur in the living organisms.

DIFFUSION

When you keep a champaka flower in a room, you experience a pleasant smell. This occurs simply because the champaka flower contains a scented substance which being transformed into a gas spreads in all directions. Again, if you put a crystal of copper sulphate or potassium permanganate in water contained in a glass container, sooner or later the water becomes coloured as the substance (consti-

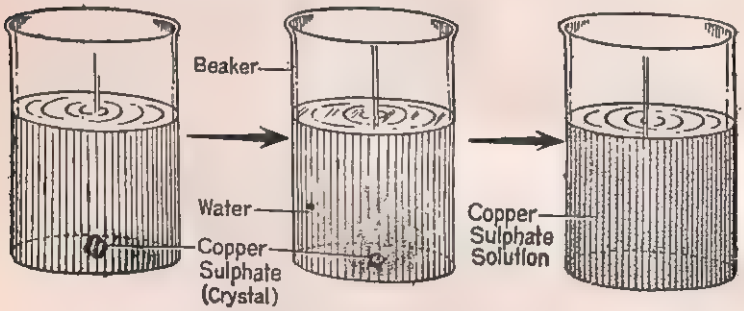
tuent of the crystal) gets evenly distributed in the water. Every substance has a tendency to be distributed from a region of its higher concentration to a region of its lower concentration and this distribution continues until the substance spreads evenly* in the available space. This phenomenon is known as *diffusion*. It occurs between (i) a gas and a solid, (ii) a gas and a liquid, (iii) two gases, (iv) two liquids, and (v) a liquid and a solid. Diffusion occurs when there is difference in concentration. It is influenced by several factors, such as temperature, surface area, etc.

EXPERIMENT 1

OBJECTIVE : DEMONSTRATION OF THE PHENOMENON OF DIFFUSION

Requirements : Beaker, rain water and a crystal of copper sulphate.

Procedure : Take some rain water, collected few



Experimental set-up for demonstrating the diffusion of a solid in water.

* A substance is made up of a good number of fine particles called molecules and these molecules, in fact, spreads from a region of higher concentration to a region of lower concentration.

minutes after beginning of the shower, in a clean breaker. Keep the beaker in a suitable place so that it is free from any disturbance. Then put the crystal of copper sulphate in the water of the beaker. Leave your experimental set-up for sometime. Then watch it carefully.

Observation : Immediately after putting the crystal of copper sulphate, it settles at the bottom of the beaker. Then it gradually goes into solution. At first a zone of deep blue colour appears near the crystal. Then the colour slowly spreads to the non-coloured parts and finally an uniformly blue coloured solution is formed.

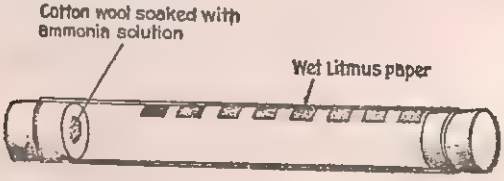
Inference : The observation indicates that the constituent parts of the copper sulphate crystal first move into the water immediately surrounding the crystal. For this reason, water immediately surrounding the crystal first becomes coloured and due to continuous movement of particles from the crystal, it (zone immediately surrounding the crystal) also becomes the zone of maximum colouration. Coloured particles also move from the zone of higher intensity to the zone of lesser intensity and from there to the zone of non-coloured water. This movement of coloured particles from the zone of higher concentration to the less coloured zones goes on continuously and as a result the whole water becomes uniformly coloured.

EXPERIMENT 2

OBJECTIVE : DEMONSTRATION OF DIFFUSION OF A GAS (AMMONIA) IN AIR

Requirements : A wide glass tube, red litmus paper, cotton, cork, a glass rod and strong ammonia solution.

Procedure : Prepare squares of red litmus paper and moisten them with water. Then with the help of the glass rod place them at equal distance on the



Experimental set-up for demonstrating the diffusion of a gas (ammonia) in air.

inner wall of the glass tube. Close one end of the glass tube with a cork and the other end by another cork containing a plug of cotton soaked in strong ammonia solution.

Observation : The red colour of the strips of litmus paper attached to the wall of the glass tube changes to blue one after the other. The strip nearest the cotton plug first changes to blue.

Inference : Ammonia gas evolves from the cotton and diffusion of it in the air of the tube takes place. When ammonia gas comes in contact with the first strip of the red litmus paper, the latter turns blue (a wet red litmus paper becomes blue when it comes in contact with any alkaline gas). As diffusion of ammonia gas proceeds towards the other

end of the tube the strips in succession become blue.

Importance of diffusion : The phenomenon of diffusion is of immense importance to the living world. One cannot think of any living process which directly or indirectly does not involve diffusion. The exchange of gases like carbon dioxide and oxygen between the plant and animal organs and the surrounding environment takes place through diffusion. Moreover, distribution of different ingredients inside the body is also effected by diffusion. So you can well think of the importance of this phenomenon in the living world.

OSMOSIS

Osmosis is a special kind of diffusion of liquids. It involves the participation of a semipermeable membrane. A semipermeable membrane is such a membrane which only allows solvent (water in case of a sugar solution) to pass through it but restricts the movement of other substances (sugar in sugar solution) that remain dissolved in the solvent. Semipermeable membrane, in the true sense, is lacking but parchment paper, air bladder of fishes, membrane of egg, etc. qualify to a great extent as semipermeable membrane.

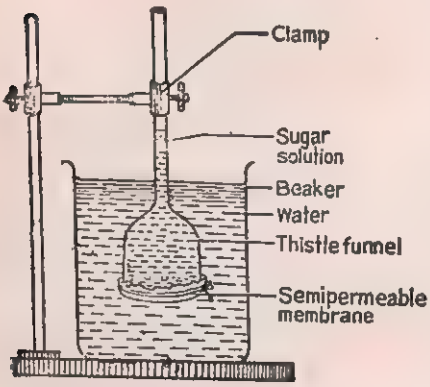
When two solutions of different concentrations are separated by a semipermeable membrane then the solvent (i.e., water in case of solutions made in water) from the less concentrated solution moves through the membrane to the more concentrated one. This process of movement of solvent through

the membrane caused by difference in concentration is called *osmosis*. Thus osmosis involves diffusion of solvents through a semipermeable membrane. Let us explain the phenomenon by the following experiment.

OBJECTIVE : DEMONSTRATION OF THE PHENOMENON OF OSMOSIS

Requirements : Concentrated sugar solution, rain water, thistle funnel, fish air-bladder, thread, beaker and stand.

Procedure : Partially fill (about 2/3rd) a beaker with rain water collected few minutes after beginning of the shower. Cover the broad mouth of the thistle funnel with one layer of the fish air-bladder. Tie the bladder with the funnel. Then invert the funnel and put the sugar solution in it (it should not fill the tube part of the thistle funnel). Then keeping the funnel in inverted position, dip the broad end of the funnel into the water of the beaker and keep it in that position with the help of the stand, Mark the level of sugar solution inside the funnel. Then keep your experimental set-up in the undisturbed condition for sometime.



Experimental set-up for demonstrating osmosis using fish air-bladder as semipermeable membrane.

Observation : After sometime you will find an increase in the level of the sugar solution inside the thistle funnel.

Inference : The increase in the level of the sugar solution inside the funnel definitely proves the entry of water from the beaker. This will be more evident if you also mark the water level in the beaker. Now if you taste the water in the beaker you will find that sugar has not escaped into it. So by this experiment we can say that only solvent has entered into the concentrated sugar solution by osmosis.

Importance of osmosis : It is none the less important phenomenon in the living organisms. The absorption of water and dissolved minerals from the soil by the roots and entry of water inside the cells of both plants and animals, etc. depend on osmosis.

ABSORPTION

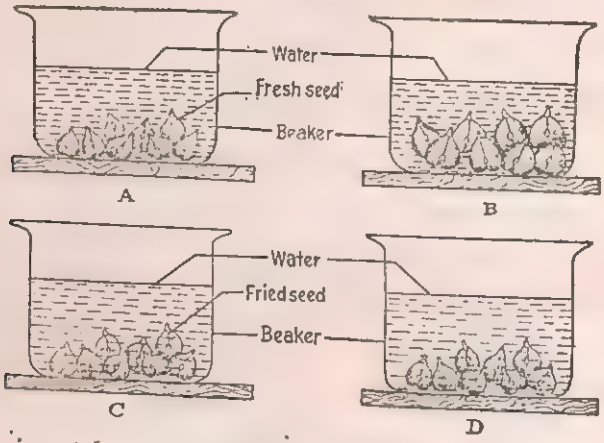
If you sow some seeds in moist soil you will find that the seeds swell up. But it does not happen if you sow them in dry soil. Why this happens ? The answer is—the seeds draw water from the moist soil. Similarly a living plant also draws water and water soluble nutrients from the soil. The phenomenon of such drawing water or other substances is known as absorption. It is one of the vital processes of the living plants and animals. Absorption is an outcome of some complicated phenomena for which living protoplasm is necessary. It can be easily proved by some simple experiments.

EXPERIMENT 1

OBJECTIVE : DEMONSTRATION OF ABSORPTION OF WATER BY FRESH SEEDS

Requirements : Gram seeds (fresh and fried), water and beakers.

Procedure : Take two separate beakers of equal sizes. Partially fill them with equal quantity of



Experimental set-up for demonstrating absorption of water by seed : A and C—at the beginning of the experiment and B & D—after the experimental period.

water. Then to one of them put some fresh gram seeds and in the other put equal number of fried gram seeds. Leave them overnight.

Observation : On the next day, you will find that fresh gram seeds have become considerably swollen but the fried gram seeds have changed little. Now remove the gram seeds from both the beakers and measure the volume of water left in the beaker. You will find that the beakers containing the fresh gram seeds contains less water than the other containing the fried gram seeds.

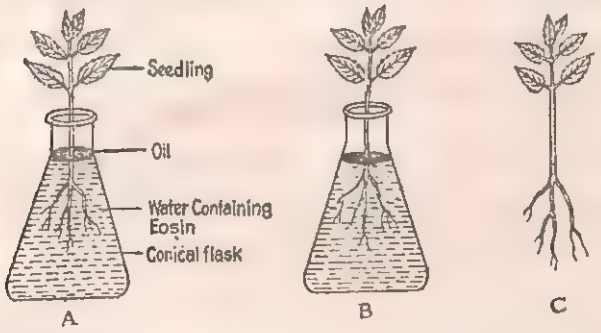
Inference : The fresh gram seeds absorbed considerable quantity of water which is evident from the swelling of seeds and also by the reduction in the water content of the beaker containing the fresh seeds. On the other hand, the fried gram seeds absorbed very little water which is evident from the negligible reduction in the water content of the beaker containing the fried seeds. The results also indicate that water absorption occurs at much higher rate when the seeds are fresh *i.e.*, when the protoplasm is living. So, it can be said that water absorption is probably controlled to a considerable extent by the protoplasm of living cells that the fresh gram seeds possess.

EXPERIMENT 2

OBJECTIVE : DEMONSTRATION OF ABSORPTION OF WATER BY ROOTED SEEDLING

Requirements : A rooted Balsam plant, water, eosin (a dye) and conical flask.

Procedure : Collect a Balsam plant from the



Experimental set-up for demonstrating absorption of water by the root : A—a Balsam plant with its root immersed in water containing eosin, B—few hours after the beginning of the experiment and C—the change in the colouration of the root.

garden with its roots intact. Wash the roots with water. Take one conical flask and fill it with water upto the neck. Put the seedling in the conical flask with its roots completely immersed under water. Add few drops of eosin (a non toxic dye) to make the water coloured. Keep your experimental set-up in undisturbed condition for few hours.

Observation : After few hours remove the Balsam plant and wash its roots thoroughly with water. Note that the roots of the Balsam plant have become coloured.

Inference : The change in the colouration of the roots indicates that water along with the dye has entered inside the roots and for this reason the colour is not discharged even after thorough washing of the roots with water.

Importance of absorption : Absorption of water and nutrients dissolved in water is very essential for the life of the plants. Animals too depend on absorption. In higher animals digested food materials and water are absorbed across the intestinal wall. Lower animals like *Amoeba* absorb water and soluble food materials through the cell membrane.

CONDUCTION

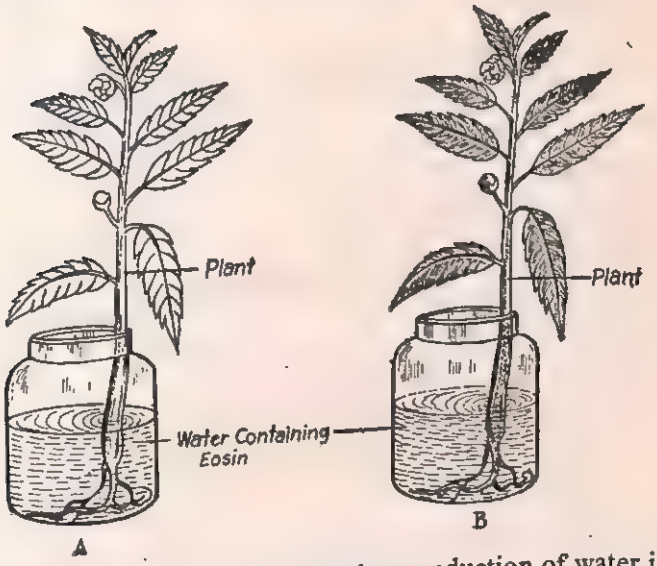
You have seen that water and minerals dissolved in water are absorbed by roots of plants. These substances do not remain confined in the roots but are transported to the leaves through the stem. In the leaves these are utilized for the preparation of food. After the preparation, the food is transferred to other parts of the body for storage or for actual utilization of it. The process by which

such transfer of materials from one part of the body to the other occurs is known as conduction. Conduction takes place through definite channels. The transport of water and dissolved minerals takes place through the xylem while the transport of prepared food (in solution) occurs via the phloem. The following experiment is designed to prove that conduction of water and dissolved minerals from the roots to leaves takes place through the xylem.

OBJECTIVE : DEMONSTRATION OF CONDUCTION OF WATER IN THE PLANT.

Requirements : A small Balsam plant (white variety), eosin solution (a dye), water, a glass bottle, glass slide, cover slip and glycerine.

Procedure : Collect a small Balsam plant from



Experimental set-up for demonstrating conduction of water in a Balsam plant : A—just at the beginning of the experiment and B—few hours after the commencement of experiment.

the garden. Wash its roots thoroughly with water. Take the glass bottle, fill it with water and then add few drops of eosin. Mix the contents of the glass bottle. Keep the Balsam plant in the glass bottle in such a way that the roots remain completely immersed in water. Leave the experimental set-up for few hours. Note the change in colour of the stem and petioles of the leaves.

Then remove the plant from the glass bottle and make few thin transverse sections of a part of the stem (see page 94). Remove one such section and place it at the centre of a clean glass slide. Add one drop of glycerine over it and cover the preparation with a clear cover slip. Place it under the microscope and ask your teacher to make necessary adjustments. Then examine the section.

Observation : After few hours you will find that the stem (actually a red line will be visible along the length of the stem) and petioles of the leaves have become reddish in colour.

Under the microscope you will find that only the xylem tissue of the vascular bundles has become reddish in colour.

Inference : The colouration of the stem and petioles indicate that water mixed with the dye has reached those parts of the plant body. Therefore, the water (along with the dye) entering the roots by absorption (see page 82) has been conducted to the leaves through the stem. In the transverse section only the xylem portion of the vascular bundles appears red. This finding indicates that water (mixed with the dye) flows through the xylem. So,

it can be concluded that conduction of water absorbed by the roots takes place through the xylem.

Importance : Conduction is a process of immense importance for the plants. Water and minerals dissolved in water are required by most plants for the manufacture of food materials in the green leaves. These substances after absorption by the roots are transported to the leaves by this mechanism. Prepared foods from the leaves are also transferred to different parts of the plant body by the same machanism. In the higher plants conduction takes place through well organized vascular tissue system.

TRANSPIRATION

In the previous experimentation you have seen that water absorbed by the roots is transferred to the leaves. The absorption of water by the roots takes place continuously. Thus water much in excess of the requirement enters the plant body. This excess water is given out in the form of vapour chiefly through very minute openings in the leaves called *stomata*. The process by which plants get rid of excess water by evaporation into the surrounding air is called transpiration. Transpiration is a special type of evaporation which occurs only in the living plants. It occurs chiefly during the daytime and is greatly influenced by factors like light, humidity, temperature, velocity of wind, etc. Transpiration is minimum in the cloudy weather. In the following section an easy method of demonstrating the occurrence of transpiration is described.

OBJECTIVE : DEMONSTRATION OF THE PHENOMENON OF TRANSPIRATION IN PLANT.

Requirements : A fresh potted plant, polythene bag and thread.

Procedure : Enclose the shoot of the fresh potted plant with the polythene bag and tie the open mouth of the bag around the base of the stem (see the figure). Place the whole set-up in bright sunlight for an hour or so.

Experimental set-up for demonstrating transpiration in plant

Observation : Droplets of water will be seen to collect on the inner surface of the polythene bag.

Inference : It is evident from the findings that water lost from the plants in the form of vapour during transpiration saturates the air enclosed in the bag. Subsequently droplets of water begins to condense on the inner surface of the bag.

Importance : Transpiration is of immense importance to the plants. When water is released in the form of vapour, especially from the leaf surface, it exerts a pull and under the influence of this pull

water and dissolved minerals are conducted to the leaves. Moreover, transpiration reduces temperature of the leaves and this enables the leaves to function normally even in presence of strong sunlight.

QUESTIONS

A. General type questions :

1. What is diffusion ? Describe an experiment to show the phenomenon using a solid and a liquid.

2. Why osmosis is known as a 'special kind of diffusion' ? Describe an experiment to show the phenomenon.

3. What in conduction ? How will you prove that conduction of water and dissolved materials occurs in plants ?

4. What is meant by absorption ? Prove that active protoplasm is essential for absorption.

5. Describe how plants get rid of excess water ? Name the phenomenon involved in the process. Describe an easy experiment to prove the occurrence of the phenomenon in plants.

B. Objective type questions :

6. Write short answer to the following questions :
   (i) What happens when two solutions of unequal concentrations are kept side by side ?
   (ii) What happens when two solutions of unequal concentrations are separated by a semipermeable membrane ?
   (iii) What is a true semipermeable membrane ?
   (iv) Why fresh seeds swell up on sowing them in moist soil?
   (v) What is conduction ?
   (vi) What is the function of xylem in the conduction in plants ?
   (vii) What is transpiration ?

7. Write 'yes' or 'no' :
   (i) Does diffusion play any role in perceiving the sweet smell of flowers ?
   (ii) Is a semipermeable membrane essential for osmosis ?

(iii) Does osmosis play any role in the absorption of water by the roots ?
(iv) Is the living protoplasm necessary for absorption ?
(v) Does the phloem play any role in the conduction ?
(vi) Does transpiration occur at night ?
(vii) Does transpiration depend on humidity ?

8. Select the correct italicised word in the following sentences :

(i) *Diffusion/osmosis* occurs when two solutions of unequal concentrations are kept side by side.
(ii) A true semipermeable membrane allows only *solvent/solution* to pass *through it.*
(iii) A crystal of copper sulphate when added to water, it mixes well to form an uniformly coloured solution—it is an example of *diffusion/osmosis/absorption.*
(iv) During osmosis solvent from the *more concentrated solution pass to the less concentrated one/less concentrated solution to the more concentrated one.*
(v) A rooted plant is placed in coloured (made with eosin) water with its roots completely immersed in it. After two hours when the plant is removed from the solution its roots are seen to be coloured. Thorough washing of the roots *will remove/will not remove* the colour.
(vi) A cross section of the above plant is made. Under the microscope the *whole section/only the xylem* appears coloured.
(vii) Transpiration *keeps/does not keep,* the leaves cool.

9. Fill in the blanks :

(i) —— occurs when there is difference in concentration between two liquids kept side by side.
(ii) A true semipermeable membrane allows only —— to pass through it.
(iii) Osmosis is a special kind of —— of liquids.
(iv) Fresh gram seeds on sowing in moist soil —— water.

CHAPTER 4

DEMONSTRATION OF CERTAIN SPECIMENS, MODELS AND CHARTS

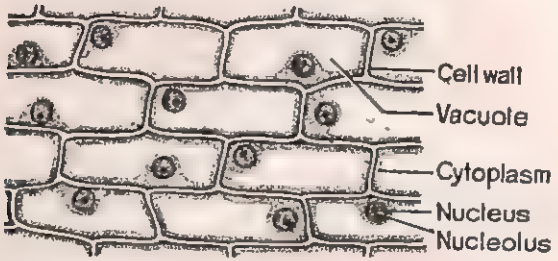
You have already become familiar with the structural and functional units of the living organisms and the organisation of these units in the body of plants and animals. But this study will not be perfect unless you observe actual specimens or do some experiments with them. Sometimes it becomes difficult to collect the actual specimens. In that case you may study some models or charts depicting their original structures. In this section we are presenting the methods of preparation of certain specimens and the method of studying them. For the study of more difficult preparations use suitable charts.

A. STUDY OF FRESH PLANT CELLS

Materials : Scales of onion, glass slide, cover slip, glycerine and a compound microscope.

Procedure : Remove the transparent membrane from the inner side of the scale of onion. Place a part of it on the centre of a glass slide. Stretch it as far as practicable with the help of two needles. Then add a drop of glycerine over it and cover the membrane carefully with a clean cover slip. Place the slide on the stage of a compound microscope. Ask your teacher to set the microscope. After he does it for you, observe the preparation.

Observation : You will find many rectangular areas bounded by lining membranes. Each rectangular areas represents a plant cell and the cell wall appears as the lining membrane. It is not possible to identify separately the cell membrane. You will



Fresh plant cells (present in the scales of onion)

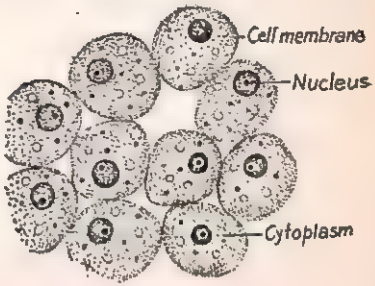
also find a dense oval body at one side of the cell. It represents the nucleus of the cell. Greater details of the nucleus and other structures will be visible to you only when the preparation is adequately stained by using suitable dye.

B. STUDY OF FRESH ANIMAL CELLS

Materials : Glass slide, cover slip, 0·9% sodium chloride solution (prepared by dissolving 0·9 g of table salt in 100 ml of water) and scrapings from the inner side of the lower lip.

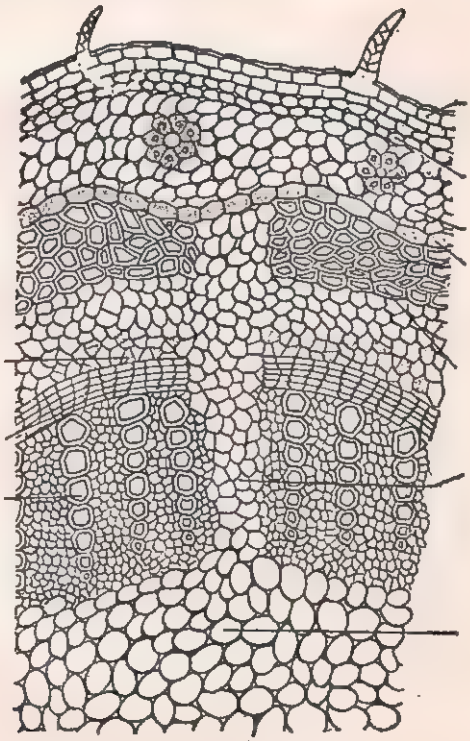
Procedure : Place one drop of sodium chloride solution (0·9%) at the centre of a clean glass slide. Then with the help of a clean cover slip scrap gently the inner side of your lower lip. Put the scraping on the salt solution. Disperse the scraping uniformly and cover the preparation with the cover slip. Remove the excess salt solution, if any, with

the help of a small piece of blotting paper. Put the slide on the stage of a compound microscope. Ask your teacher to set the instrument and then observe the preparation under the microscope.



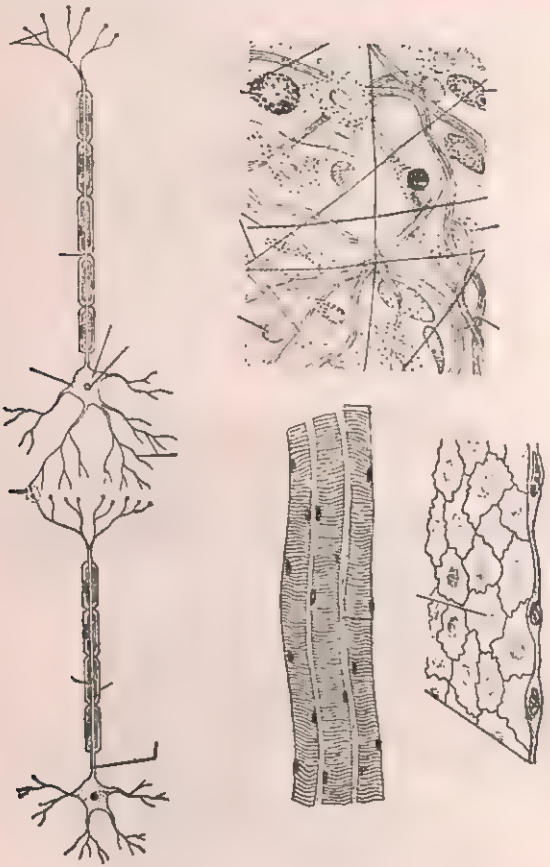
Few fresh animal cells

Observation : You will find a group of cells some of which may be totally isolated from the others. The cells will appear to



Cross section of a sunflower stem.

possess irregular cell outline. Each cell will also reveal a dense oval region which represents the nucleus of the cell. Other structural details will



Few animal tissues.

be visible only when you stain them with suitable dye and observe the preparation under greater magnification.

C. STUDY OF PLANT TISSUES

Transfer a thin section of the sunflower stem (for section cutting see page 94) at the centre of a glass

slide. Put a drop of glycerine on it and then cover the preparation with a cover slip. Examine the slide under the microscope. For adjusting the microscope take the help of your teacher.

Under suitable adjustment of the microscope you will find structures as depicted in the figure on page 91. As you have already studied the different tissues present in a section of a young dicot stem, you will not find any difficulty in labelling it.

D. STUDY OF ANIMAL TISSUES

Preparation of different animal tissues is much difficult. For this reason, use suitable charts for studying the different animal tissues. We have presented unlabelled diagrams of four different animal tissues studied by you in page 92. So you won't find any problem in labelling them.

E. FREE-HAND SECTION CUTTING METHOD

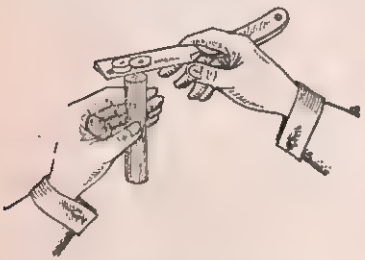
You know that the organs of plants and animals contain many cells organized into definite patterns. Our eyes cannot see minute structures but this difficulty can be avoided if instrument called microscope is used. For microscopic study a section of a plant or animal organ is used. A clear view of the organisation of the different constituents can only be made when the section is very thin. In the following section we shall describe how thin sections of plant organs can be made.

A razor (plano-concave)* is used to cut sections

*A shaving blade is often used for cutting section of plant organ but these sections may not be uniform unless special care is taken.

of root, stem and leaf. The razor must be sharp and free from nicks. To cut sections, the razor should be held in such a position that the handle and the blade of the razor make right angle with each other. The handle must remain free, while the index finger is placed on the hooked end of the razor. First, second and third fingers are kept against the thick back edge of the blade while the thumb remains pressed against the milled surface of thick shank of the blade. At the time of section cutting, both the material and the razor should be flooded with water.

In cutting sections of a root, usually a young root of gram is taken. The root is first cut into pieces (2-3 cm.) for easy holding of the same. It is then kept in a watch glass containing some amount of water. While cutting sections, a piece of root is held in hand between the thumb and the fingers of the left hand. It should lie almost at right angle to the razor edge so that thin as well as uniform sections can be cut. The razor is then moved rapidly over the piece of root and the stroke is completed in one action. Sections sould be cut by sliding the razor over the root in uniform strokes for few times. In case of a delicate root, a rectangular piece of carrot called pith is used. A hole is made with the help of a needle to insert the root inside the pith. This

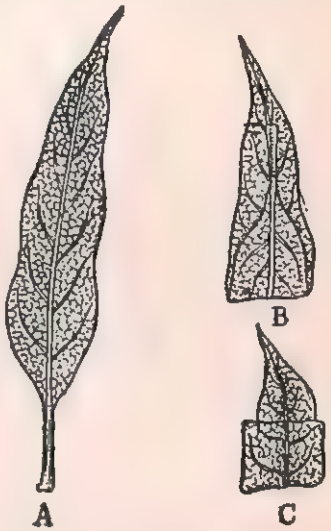


Holding of the razor for cutting sections of a stem.

process of insertion is adopted for easy holding. Sections of the delicate root are thus made along with those of the pith.

During cutting sections of a stem, usually a young stem of sunflower is taken. The process of cutting sections of the stem is similar to that of the root.

In cutting sections of a leaf, usually a young leaf of mango is taken. Since the leaf is very thin, it should be folded from below upwards for several times before sections can be made (see figure). The process of cutting section of the leaf is otherwise similar to that of the root or the stem.

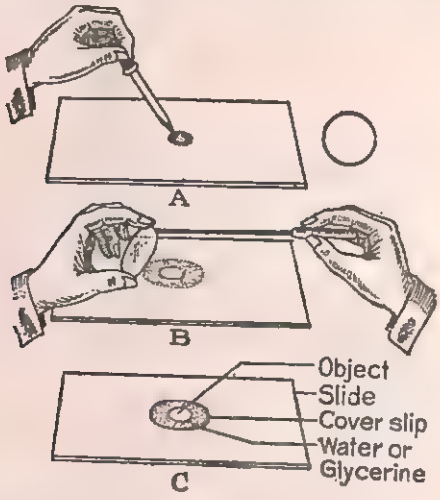


Steps (A—C) in the folding of a leaf

Sections thus cut are transferred with the help of a fine hair brush to another watch glass containing some amount of water. Once the section cutting is over, the razor should be dried, greased and encased. Sections are then selected for study. If a section is thin and uniform, it will float uniformly on the surface of water.

Mounting : After selection of a thin section, remove it from the watch glass with the help of a brush and place it on a drop of water taken at the centre of a clean glass slide. Then take a clean cover slip and hold it with the index finger and

thumb of the left hand in an inclined position. So that one end of the cover slip touches the water droplet at the centre of the glass slide. Take a needle and hold it with the right hand. The needle should be kept in such a position that the cover slip



Method for mounting a specimen (A—C)

can rest on it. Then slowly pull the needle to the right so that the cover slip finally rests over the section. Care should be taken so that no air bubble gets entrapped in between the glass slide and the cover slip. Remove the excess water and then place it under the microscope for necessary study.

QUESTIONS

A. General type questions :

1. Describe a method of preparation of plant cells for microscopic observation. Draw a neat sketch of the cells which can be seen when the preparation is examined under the microscope.

2. Draw a neat sketch of the cross section of a young sunflower stem. Label the different tissues present in it.

3. Draw a neat sketch of few skeletal muscle fibres. Label the different parts of a skeletal muscle fibre.

4. Describe the free-hand section cutting method of a young dicot stem.

B. Objective type questions :

5. Write short answers to the following questions :—

(i) How are the cells present in the inner membrane of the scales of onion look like ?

(ii) What are the tissues present in the ground tissue system of a young sunflower stem ?

(iii) How will you identify the simple squamous epithelium from other tissues ?

(iv) Why thin sections of plant organs are made ?

(v) Which section of a plant organ is ideal for microscopic study ?

6. Select the correct italicised word in the following sentences :

(i) Plant cells present in the inner membrane of the scales of onion appear *rectangular/oval* in shape.

(ii) The epidermal tissue system of sunflower stem consists of *many layers/a single layer* of parenchymatous cells.

(iii) A *plane/plano-concave* razor is used for cutting free-hand sections of plant organs.

(iv) During section cutting it is *essential/not essential* to keep the blade of the razor at right angle to the stem.

(v) Thin uniform sections float *uniformly/does not float uniformly* on the surface of water.

CHAPTER 5

FREE-HAND TRANSVERSE SECTION CUTTING OF A YOUNG DICOT STEM

You have come to know that most of the multicellular organisms consist of many cells which are organised into different tissues. The constituent cells of these tissues are not visible to the naked eye. To avoid this difficulty, instrument like compound microscope is used. As only thin sections of specimens allow light rays to pass through it, only such sections can be used for microscopic studies. In the following section the procedure for preparing thin sections of a young dicot stem is described.

Materials : A razor (plano-concave), watch glass, hair brush, young sunflower stem and water.

Procedure : (1) Collect few pieces of young fresh sunflower stem. Cut them into small pieces of 2-3 cm long and keep them in a watch glass containing water.

(2) Take a sharp but nick free razor.

(3) Remove the adherent greeze from the both surfaces of the razon-blade. Use cotton wool soaked with xylol to remove the grease. Then use cotton wool soaked with alcohol to remove the adherent xylol. Wash the razor-blade thoroughly with water.

(4) Hold the razor with its concave surface facing upwards in such a way that the blade of the razor and the handle make right angle to each other.

Place the index finger on the hooked end of the razor. Keep first, second and third fingers against the thick back edge of the razor blade while the thumb should remain pressed against the milled surface of thick shank of the blade.

(5) Hold a piece of stem in between the thumb and the fingers of the left hand. It should remain at right angle with the blade of the razor during section cutting and project a little above the left index finger.

(6) Put some water on the concave surface of the blade of the razor and place the plane surface of the razor-blade on the index finger of the left hand.

(7) Cut few thin sections of the stem by sliding the razor over the stem by uniform strokes for few times. Care should be taken to complete each stroke in one action.

(8) Remove the cut sections with the help of a hair brush and put them in the watch glass containing water.

(9) After section cutting is over, remove the adherent water from the surface of the blade of the razor, make it dry, apply greaze on both the surfaces and encase it.

(10) For the study under microscope select only those sections which are thin and float uniformly on the surface of water.

APPENDIX

A. EXPERIMENTATION AND RECORDING OF DIFFUSION, OSMOSIS AND CONDUCTION

In chapter 3, we have presented methods for demonstrating diffusion, osmosis and conduction through simple experiments. Perform the following experiments yourself and record the procedure for the experiment and the observations made by you in the tabular form depicted below.

(1) OBJECTIVE : DEMONSTRATION OF DIFFUSION OF A GAS IN AIR.

Procedure	Observation

(2) OBJECTIVE : DEMONSTRATION OF OSMOSIS USING FISH AIR-BLADDER AS THE SEMIPERMEABLE MEMBRANE.

Procedure	Observation

(3) OBJECTIVE : DEMONSTRATION OF CONDUCTION IN BALSAM PLANT.

Procedure	Observation

B. OBSERVATION AND RECORDING OF THE EXTERNAL FEATURES OF TOAD

While studying in class VII you have already gained knowledge on the external features of a toad. With that background you study the external features of a toad and present your findings in the table given below.

Note : You may face trouble in studying a living specimen as it will try to move away. To avoid this difficulty you may place it in a glass jar, pour few drops of chloroform and put the lid on the mouth of the jar. After few minutes the toad will become unconscious and you won't face any problem to manage a unconscious toad.

OBJECTIVE : STUDY OF THE EXTERNAL FEATURES OF A TOAD.

PARTICULARS :	OBSERVATION
1. Colour of the animal :	
2. Texture of the skin :	
3. General shape :	
4. Shape of the head :	
5. Structures present on the head region and their shapes :	
6. Structures present on the trunk and their shapes :	

—: NOTE :—